MEASUREMENT PROTOCOL FOR COMMERCIAL, INDUSTRIAL AND RESIDENTIAL FACILITIES

Prepared in the context of the implementation
of New Jersey's Demand Side Management Rules

April 28, 1993

ACKNOWLEDGEMENTS

This document was prepared in the context of a collaborative process in the State of New Jersey involving, among others, staff of the New Jersey Board of Regulatory Commissioners (NJ BRC), New Jersey Department of Public Advocate, New Jersey electric utilities (Utilities), energy services companies (ESCO's), and contractors. Specifically, this Measurement Protocol was developed to implement, in conjunction with the measurement plans contained in the Utilities' Demand Side Management (DSM) Plans, the measurement requirements contained in the Demand Side Management rules set forth in N.J.A.C. 14:12-1 et seq (Regulations).

The people primarily involved in the development and articulation of this document were Skip Moss (Sure Energy Services Inc.) and Richard Rathvon (SYCOM Enterprises), Bill Barretti (NJ BRC), Joseph Bowring (Rate Counsel), Charles Coccaro (PSE&G), Jim Frieband (EUA Cogenex), Linda Gettings (Kenetech Energy Management), and Chris Siebens (JCP&L). In addition, this document reflects the input of numerous others involved in the collaborative process, including, but not limited to:

Doug Ames, Transphase Systems, Inc.
Norman Adelman, NJ Coalition for Fair Competition
Rich Aicher, JCP&L Co.
Michael Ambrosio, New Jersey Board of Regulatory Commissioners
Bill Barretti, New Jersey Board of Regulatory Commissioners
Joe Bowring, Department of Public Advocate, Division of Rate Counsel
Central Hudson Enterprises, Inc.
Charlie Coccaro, PSE&G Co.
Art Coughlin, Public Service Conservation Resource Corp.
Jim Cucarro, Orange & Rockland
Tom Dreessen, CES/Way International, Inc.
Patricia Ehrhart, Atlantic Electric
Richard Esteves, SESCO, Inc.
Jim Frieband, EUA Cogenex Corp.
Linda Gettings, Kenetech Energy Management, Inc.
Jim Halpern, Measuring & Monitoring Services, Inc.
John Jensen, Public Service Conservation Resource Corp.
Robert Krizman, SYCOM Enterprises
Art Lennon, EUA Cogenex Corp.
Bill Machold, Enersave, Inc.
David McGeown, Trend Control Systems, Inc.
Skip Moss, Sure Energy Services Inc.

Martin Mozzo, Kenetech Energy Management, Inc.
Richard D. Rathvon, SYCOM Enterprises
George Reeves, George Reeves Associates, Inc.
Mike Roddy, JCP&L Co.
Ted Schnipper, Proven Alternatives
Chris Siebens, JCP&L Co.
Jose Torres, PSE&G Co.

Special appreciation is expressed to Charles Coccaro (PSE&G), Skip Moss (Sure Energy Services, Inc.), Richard Rathvon (SYCOM Enterprises) and Chris Siebens (JCP&L) for compiling the information in this document.

MEASUREMENT PROTOCOL FOR COMMERCIAL AND INDUSTRIAL FACILITIES

Table of Contents

I. OVERVIEW

II. COMMERCIAL AND INDUSTRIAL FACILITIES

A. Method 1: Measures Affecting Constant Load, Constant Operating Hours, Non-Weather Sensitive End Uses (But Not Affecting Operating Hours)

B. Method 2: Measures Affecting Operating Hours of Constant Load, Non-Weather Sensitive End Uses

C. Method 3: Measures Affecting Variable End Use Requirements

D. Method 4: Other Technology Specific Measurement Methodologies

1. Method 4A: Thermal Storage
2. Method 4B: Heat Recovery
3. Method 4C: Energy Management System

III. RESIDENTIAL WHOLE HOUSE WEATHERIZATION

IV. APPENDICES: TECHNICAL EXHIBITS AND MEASUREMENT EXAMPLES

A. Appendix A: Technical Exhibits

1. Exhibit 1: Luminaire Wattage Table

2. Exhibit 2: De-rating Tables (Table 1) and Default Efficiency Table (Table 2)

3. Exhibit 3: Determination of Constant Loads for Motor Applications

B. Appendix B: Measurement Examples for Method 1

1. Example 1: Inefficient Lighting Fixtures Are Retrofitted with Efficient Lighting Measures

2. Example 2: Pump Motor is Replaced with a New Energy Efficient Motor in a Constant Load Situation

3. Example 3: HVAC Fan Motor is Replaced with a Smaller, Properly Sized HVAC Fan Motor

C. Appendix C: Measurement Examples for Method 2

[Intentionally Left Blank]

D. Appendix D: Measurement Examples for Method 3

1. Example 1: Pump Motor Is Replaced with a New Energy Efficient Motor in a Varying Load Situation

2. Example 2: Constant Load Pump Is Retrofitted with a Variable Frequency Drive to Satisfy Same End-Use Requirement

3. Example 3: Chiller System Efficiency Is Improved

4. Example 4: Sewage Lift Station Pump and Motor Is Equipped with a Variable Frequency Drive

5. Example 5: Process Change Application

E. Appendix E: Measurement Examples for Method 4

I. OVERVIEW

Measurement of actual energy savings resulting from improvements in energy efficiency is fundamental to the delivery of a firm, reliable resource to utilities. Measurement of energy savings allocates risk among the utility, customer, and contractor. Measurement of energy savings also quantifies the benefits to the customer, ratepayer, utility and society.

This document articulates what the interested parties believe are currently the most appropriate measurement technologies and methodologies. However, it is intended that the application of these technologies and methodologies over time shall be flexible as more information and further refinement is gained through experience.

This Measurement Protocol outlines the requirements for the measurement of electric energy and capacity savings resulting from a Utility's Demand Side Management (DSM) Plan. This Measurement Protocol is intended to be implemented in conjunction with: (i) the measurement plans contained in the Utilities' DSM Plans; (ii) a Sampling Plan developed by each Utility (which may be part of the Utility's measurement plan contained in its DSM Plan) and approved by NJ BRC Staff and Rate Counsel; and (iii) Verification Procedures developed by each Utility (which may be part of the Utility's measurement plan contained in its DSM Plan) and approved by NJ BRC Staff and Rate Counsel. All Utility measurement plans, the Sampling Plan, and Verification Procedures must be consistent with the principles presented in this Measurement Protocol, and will be attached to this document when they are approved.

The Measurement Protocol sets forth methodologies that describe the means and principles involved in determining savings from general classifications of energy savings measures. The methods are grouped generally by usage patterns and the operating principles of the electric load controlled or modified. This Measurement Protocol also contains examples of how each methodology is to be applied to a specific technology or system improvement. The inclusion of a specific technology or system improvement as an example indicates the approved measurement methodology for that technology or system improvement, and are set forth in Appendix B. Any substantive deviations from the examples and their intent must be approved by NJ BRC Staff and Rate Counsel in order for the energy savings (as measured under the Measurement Protocol) to be used for the purpose of payments by a Utility or the earning of Utility incentives and recovery of lost revenue.

In addition, the technical exhibits contained in Appendix A set forth certain standards that apply to the Protocol and examples. Any substantive deviations from the technical exhibits and their intent must be approved by NJ BRC Staff and Rate Counsel, or by the NJ BRC.

I. OVERVIEW

Measurement of actual energy savings resulting from improvements in energy efficiency is fundamental to the delivery of a firm, reliable resource to utilities. Measurement of energy savings allocates risk among the utility, customer, and contractor. Measurement of energy savings also quantifies the benefits to the customer, ratepayer, utility and society.

This document articulates what the interested parties believe are currently the most appropriate measurement technologies and methodologies. However, it is intended that the application of these technologies and methodologies over time shall be flexible as more information and further refinement is gained through experience.

This Measurement Protocol outlines the requirements for the measurement of electric energy and capacity savings resulting from a Utility's Demand Side Management (DSM) Plan. This Measurement Protocol is intended to be implemented in conjunction with: (i) the measurement plans contained in the Utilities' DSM Plans; (ii) a Sampling Plan developed by each Utility (which may be part of the Utility's measurement plan contained in its DSM Plan) and approved by NJ BRC Staff and Rate Counsel; and (iii) Verification Procedures developed by each Utility (which may be part of the Utility's measurement plan contained in its DSM Plan) and approved by NJ BRC Staff and Rate Counsel. All Utility measurement plans, the Sampling Plan, and Verification Procedures must be consistent with the principles presented in this Measurement Protocol, and will be attached to this document when they are approved.

The Measurement Protocol sets forth methodologies that describe the means and principles involved in determining savings from general classifications of energy savings measures. The methods are grouped generally by usage patterns and the operating principles of the electric load controlled or modified. This Measurement Protocol also contains examples of how each methodology is to be applied to a specific technology or system improvement. The inclusion of a specific technology or system improvement as an example indicates the approved measurement methodology for that technology or system improvement, and are set forth in Appendix B. Any substantive deviations from the examples and their intent must be approved by NJ BRC Staff and Rate Counsel in order for the energy savings (as measured under the Measurement Protocol) to be used for the purpose of payments by a Utility or the earning of Utility incentives and recovery of lost revenue.

In addition, the technical exhibits contained in Appendix A set forth certain standards that apply to the Protocol and examples. Any substantive deviations from the technical exhibits and their intent must be approved by NJ BRC Staff and Rate Counsel, or by the NJ BRC.

The methodologies (including the specific examples and technical exhibits contained in the appendices) set forth herein shall be revised as new and/or better means of measurement become available. Changes and additions to this document will be made on a case-by-case basis subject to the approval of NJ BRC Staff and Rate Counsel after consultation with the Utilities, ESCO's, and other interested parties. In order not to delay projects and thereby miss opportunities, NJ BRC Staff and Rate Counsel shall expedite this review and approval process. However, where the change or addition varies significantly from the methodologies herein, or there is significant disagreement, it may be submitted to the NJ BRC for resolution.

As new methods or examples are approved by NJ BRC Staff and Rate Counsel or by the NJ BRC, they will be attached to this document as additional examples in the Appendices. Specifically, the Measurement Protocol has not resolved, in many cases, how to address the interactive savings resulting from efficiency improvements. Therefore, this issue, provided for in the Regulations, will be resolved as information, experiments and evidence as to the validity of proposed values and methodologies are provided to the parties.

It is intended that NJ BRC Staff and Rate Counsel shall have access to all measurement and verification data with respect to projects implemented under a Utility DSM Plan and this Protocol, subject to reasonable confidentiality requirements of customers, the Utility and ESCO's.

While meeting the consistency requirement, Utility measurement plans will likely contain a greater level of detail appropriate to the design of the specific DSM programs and rate recovery method of the Utility's DSM Plan. As appropriate, each Utility measurement plan must comply with the following and/or be consistent therewith:

<u>Free Rider Adjustments</u>: Each Utility shall specify the free ridership effect, if any, applicable to DSM programs implemented for its customers so that savings measured under the Measurement Protocol may be modified as appropriate to account for these effects.

<u>T&D Line Loss Adjustments</u>: Each Utility shall provide adjustments for line loss effects resulting from power savings benefits. These may be factored into either price or power savings methodologies using procedures accepted by NJ BRC Staff and Rate Counsel, or by the NJ BRC.

<u>Capacity Reserve Margin</u>: Each Utility shall incorporate the value of capacity reserve margin into its avoided cost pricing.

Metering Standards: Metering shall generally use measurement technologies capable of providing accurate results, consistent with the Utility Time Periods (for peak, off peak, system peak, seasons, etc.). Optimally, continuous metering providing hourly data will be used. The costs of installing and maintaining such systems, as well as the costs of collecting and evaluating hourly data for the number of measurement points involved, allow for alternative plans, so long as such plans have been approved by the NJ BRC Staff and Rate Counsel.

Sampling Plans: Each Utility shall propose specific sampling plans and criteria for measurement, subject to the approval of the NJ BRC. Such plans should be designed to provide, as a target, a 90% confidence that savings equal or exceed the value measured, and shall be sufficiently robust to account for persistence. Whenever a sample is used, it shall be consistent with the approved Sampling Plan.

Utility Time Periods: Each Utility may specify Time Periods appropriate to assessing the value of savings. These would generally include seasonal energy periods for peak and off peak savings, and periods for assessment of system peak impacts or customer demands on a monthly or seasonal basis.

Duration of Measurement: Metering to assess continuing savings will be required throughout the term of claimed savings. Certain performance tests using temporary metering will be used for an appropriate duration to record data over the full range of expected conditions affecting savings. The duration of such tests will be established on a case-by-case basis; guidelines for specific technologies are included herein.

Verification Procedures: Each Utility shall set forth procedures defining how it will verify information concerning the installation of efficiency measures, persistence of energy savings and level of service (e.g., footcandle levels). These procedures shall be specific enough to ensure accuracy of energy savings measurement.

II. COMMERCIAL AND INDUSTRIAL FACILITIES

A. METHOD 1: MEASURES AFFECTING CONSTANT LOAD, NON-WEATHER SENSITIVE END USES (BUT NOT AFFECTING OPERATING HOURS)

1. Types of Measures

The measures addressed under Method 1 improve the efficiency of electric end-use systems that have a constant load (as defined in Appendix A, Exhibit 3), independent of time of day or season, whenever operated. These measures have no impact on the operating hours of the end-use systems, and include, but are not limited to:

- Replacement of standard efficiency fluorescent lamps and ballasts with high efficiency lamps and ballasts.
- Installation of specular reflectors in fluorescent fixtures, accompanied by elective removal or replacement of a portion of fixture lamps.
- Conversion from incandescent to fluorescent fixtures.
- Conversion of industrial incandescent, fluorescent, or mercury vapor fixtures to high pressure sodium or metal halide fixtures.
- Replacement of oversized and inefficient motors operating at a constant load with appropriately sized, high-efficiency motors.

2. Measurement Methodology

The proposed measurement method for this class of measures and systems is as follows:

a. For lighting measures that do not modify hours of lighting operation, perform the following:

   i. Establish baseline connected load (kW). For lighting measures, this shall be the sum of Utility accepted connected loads for each existing luminaire type to be replaced or modified. Accepted connected load shall be shown in a Luminaire Wattage Table (similar to New England Electric System's (NEES) Luminaire Table). See discussion below at Paragraph 2.c.i regarding developing and updating the Luminaire Tables. This Luminaire Table shall be set forth in Appendix A, Exhibit 1.

ii. Establish post-installation connected load (kW) with respect to the installed luminaires as the sum of either the Utility accepted connected loads for luminaires (as derived from the Luminaire Tables set forth in Appendix A, Exhibit 1) or the actual measured kW of the installed luminaires subject to Paragraph 2.c.i below (or sample thereof). Where an ESCO chooses to derive kW from the actual measured kW of the installed luminaires (or sample thereof), then such ESCO must apply this same methodology to all installations. Compare pre- and post-installation connected loads to determine load reduction.

iii. Concurrent with installation of lighting measures, install permanent metering on individual devices or control circuits, or a sampling of devices or control circuits (see discussion below at Paragraph 2.c.iv regarding metering).

iv. Measure energy savings as the product of connected load reduction from Step 2.a.ii. and run hours from Step 2.a.iii for applicable Utility Time Periods. Where multiple run-hour meters are used to monitor run-hours for a sample group, use a simple or weighted average (based on connected load) of run-hour meter readings, if differences exist, to determine run hours for each such group, all in accordance with a Utility's Sampling Plan. See discussion below at Paragraph 2.c.ii regarding sampling.

v. Use the following formulae for the computation of energy savings and connected load reduction for each Utility Time Period:

A. kWh savings shall be determined by:

$$kWhpd = kWd * hrspd$$

Where:

kWhpd is the kWh savings for each Utility Time Period; and

hrspd is: (1) the metered run time per each Utility Time Period after measure installation; or (2) estimated as the product of total measured run hours and the measured Time Period percentage (Time Period use divided by total use) of energy use or operating hours for a sample of substantially equivalent circuits.

B. Connected load reduction shall be determined by:

$$kWd = kWd_{pre} - kWd_{post}$$

Where:

kWd is the reduction in connected load resulting from the installation of the measures;

kWd_{pre} is the connected load of the device (or the sum total of all applicable devices) prior to measure installation as determined in accordance with Step 2.a.i above; and

kWd_{post} is the connected load of the device (or the sum total of all applicable devices) after measure installation as determined in accordance with Step 2.a.ii above.

vi. Capacity savings shall be measured by energy savings over a specified period of time during which a Utility typically achieves its seasonal system peak(s). Use the following formula to determine capacity savings:

Capacity Savings = kWhcp / Total Capacity Period hours

Where:

kWhcp is the energy savings during the Utility's applicable capacity period or periods.

The capacity period or periods shall be determined by each Utility as approved by the NJ BRC.

b. For motors under a constant load, perform the following:

i. With respect to determining the load on the existing motor:

A. Where the installation involves only the simple replacement of a motor where no other efficiencies in the system are to be obtained, use the manufacturer's performance curve of efficiency versus percent full load. If such manufacturer's performance curves are not available, use the nameplate efficiency at full load coupled with the de-rating table set forth in Table 1 of Appendix A, Exhibit 2. If the nameplate efficiency is not available, then use the default tables set forth in Table 2 of Appendix A, Exhibit 2, in conjunction with the derating table (Table 1 of Appendix A, Exhibit 2).

B. Where the installation involves the improvement to the system of which the motor is a part, conduct recording wattmeter measurements of the motor over a representative operating period before applying the efficiency measure to the system.

ii. Determine whether the load is constant using the methodology set forth in Appendix A, Exhibit 3.

iii. Measure the load on each new motor (or a sample of motors consistent with a Utility's Sampling Plan) continuously or over a representative time period. If load is measured over a representative time period, the load must be measured over this representative period annuallyin order to confirm that the load has not substantially changed. Apply this measured load to the performance curve to determine the percent full load of the new motor.

iv. Reduction in load shall be the difference between the load determined in Step 2.b.i and Step 2.b.iii. The load of the new motor measured in 2.b.iii shall be applied to the old motor performance curve to determine the corresponding kW of the old motor. Reduction in kW shall be the difference between this kW (for the old motor) and measured kW of the new motor measured in Step 2.b.iii.

v. Install run-hours or kWh metering on individual motors (or on a sample of motors consistent with a Utility's Sampling Plan) concurrently with installation of the motor.

vi. Measure savings as the product of load reduction from Step 2.b.iv and run-hours from Step 2.b.v. For multiple run-hours meters making up a device group sample, use a load weighted average of run-hour meter readings, if differences exist, to determine run-hours for the group.

vii. Capacity savings shall be measured by energy savings over a specified period of time during which a Utility typically achieves its seasonal system peak(s). Use the following formula to determine capacity savings:

Capacity Savings = kWhcp / Total Capacity Period hours

Where:

kWhcp is the energy savings during the Utility's applicable capacity period or periods.

The capacity period or periods shall be determined by each Utility as approved by the NJ BRC.

c. Other issues related to measurement under this Method 1 are as follows:

i. The electric utilities shall cooperatively prepare the Luminaire Tables, which shall be approved by NJ BRC Staff and Rate Counsel and be incorporated into this Protocol as Appendix A, Exhibit 1. Such utilities shall update these tables, in accordance with procedures acceptable to NJ BRC Staff and Rate Counsel, to reflect corrections and new information on an as-needed basis. Any corrections or updates approved by NJ BRC Staff and Rate Counsel shall amend Appendix A, Exhibit 1. If a lighting configuration is not addressed in the Luminaire Table with respect to an existing or new configuration, the Utility shall, if appropriate, add such configuration to the Luminaire Table based upon certified test results conducted in accordance with ANSI Standard C82.2. Alternatively, with respect to an old configuration not currently listed in the Luminaire Table, such configuration may be tested in the field up to a cumulative maximum of 50 kW of load reduction or five host facilities, whichever is less. Beyond this maximum, the configuration shall be tested in accordance with ANSI Standard C82.2 and added to such Table.

ii. Where sampling of devices or circuits are involved, such sampling shall be done in accordance with the Utility's Sampling Plan.

iii. While this Method 1, and the referenced examples in Appendix B, may refer to on-peak and off-peak hours, a Utility may utilize different Time Periods (e.g., intermediate peak) or divide the peak time into various categories or windows (e.g., seasonal peaks). The methodologies set forth in this Method 1 are intended to apply identically to these other Utility Time Periods.

iv. Metering alternatives shall be as follows, subject to a Utility's Verification Procedures:

A. seasonally differentiated time metering capable of registering on-peak and off-peak hours of operation, or other Utility Time Periods appropriate to a Utility's rate or incentive valuation structure;

B. a digital monitoring device programmed to differentiate and record run hours for Utility Time Periods appropriate to a Utility's rate or incentive valuation structure of devices or circuits monitored with current transducers capable of sensing operation of controlled devices or circuits that are calibrated to sense circuit operation at not less than 75% of verified amperage.

Metering shall be accessible and capable of being audited by the Utility. If computerized metering equipment is used, it must be accessible remotely through a modem and capable of being audited by the Utility. In addition, a metering plan shall be required for each facility setting forth which circuits or motors are to be measured consistent with a Utility's Sampling Plan.

v. If post-installation light levels are less than the light levels existing prior to installation, energy savings shall be reduced proportionately to the measured light level reduction. Lighting levels shall be verified in accordance with a Utility's Verification Procedures.

vi. The number of fixtures that shall be examined in order to determine pre- and post-connected load shall be set forth in the Utility's Verification Procedures.

vii. Unless otherwise specifically measured, an interactive factor of 5% of the measured lighting energy and capacity savings where lighting measures are installed in conditioned space will be credited (annually during the period of measurement) to reflect the secondary demand and energy savings in reduced HVAC consumption resulting from decreased indoor lighting wattage. The Utilities and ESCO's shall work together to develop a measurement methodology acceptable to NJ BRC Staff and Rate Counsel that accounts for the interactive effects of lighting on heating and cooling loads.

viii. If required by a Utility's Verification Procedures, the measurement steps above will be conducted in the presence of, and recording data will be made available for review by, NJ BRC Staff, Rate Counsel or Utility representative.

3. Duration of Measurements

For each host facility, a proposed sampling and duration of measurement plan will be submitted to the Utility for review and approval prior to proceeding with measure implementation. Post-installation measurement will be continuous for the life of the benefits claimed.

4. Example Application

An approved example illustrating the application of this methodology to replacement of lighting is presented in Appendix B, Example 1. Approved examples illustrating the application of this methodology to replacement of motors is presented in Appendix B, Example 2 and Example 3. Additional examples may be attached hereto once approved by the Utility, NJ BRC Staff and Rate Counsel, or by the NJ BRC, as set forth in the Overview to this Protocol.

B. METHOD 2: MEASURES AFFECTING OPERATING HOURS OF CONSTANT LOAD, NON-WEATHER SENSITIVE USES

1. Types of Measures

The measures addressed under Method 2 reduce the operating hours of electric end-use loads that have a constant demand when operating by eliminating unnecessary operation (via active, automatic control) without adversely affecting delivery of, or degrading the level of, necessary facility services.

2. Measurement Methodology

3. Duration of Measurements

4. Example Applications

C. METHOD 3: MEASURES AFFECTING VARIABLE END USE REQUIREMENTS

1. Types of Measures

The measures addressed under Method 3 improve the efficiency of electric end-use loads that have a variable demand. Some of these measures predominantly affect production systems and requirements (independent of weather effects), and the measurement methodology with respect to such measures is designed to measure such system output as a function of demand and/or energy use. These measures focus mainly on electric motor systems and processes, and include, but are not limited to:

- Replacement of variable volume or motor speed control devices with variable frequency drives.
- Modification of constant speed or constant volume system with variable frequency drives serving a variable end use requirement.
- Installation of high-efficiency variable load motors.
- Conversion from constant volume to variable volume air handling systems.
- Replacement of variable volume or motor speed control devices with variable frequency drives.
- Installation of high-efficiency motors (for variable loads only).
- Improvement of manufacturing process efficiency.

In certain situations, the performance of electric end-use loads may vary due to effects of weather. In these situations, measurement of energy savings incorporating weather effects may be appropriate. These end-use loads primarily involve HVAC systems, and include:

- Chiller plant upgrading projects where the affected chillers serve process loads only.
- Replacement and modification of existing water chiller systems or direct expansion refrigeration systems with more efficient equipment and systems.
- Provision of water-side or air-side free-cooling capabilities on existing cooling systems.
- Control system functions affecting weather dependent uses (e.g., air-side economizer optimization, supply air temperature reset, chiller plant optimization).

2. Measurement Methodology

The measurement methodology for the measures and improvements in this Method 3 requires continuous end-use metering of the electrical input and the loading/output of the devices affected by such measures and improvements for the life of the measure or over the period for which benefits are claimed. As set forth in the Overview of this Protocol, specific examples illustrating the application of this Method 3 to specific types of energy conservation projects shall be submitted to the NJ BRC Staff and Rate Counsel for approval after agreement by the Utility.

Savings measurement methodology for this class of measures is as follows:

a. Prior to installation of the measure:

   i. Conduct recording wattmeter measurements of the electrically powered system over a representative operating period before applying the efficiency measure to the system. Electrical data will be measured at the point that best represents the energy efficiency improvement measure. Historical data may also be utilized if of adequate quality, if available and if acceptable to the Utility, NJ BRC Staff, and Rate Counsel, or to the NJ BRC.

   ii. Measure system output ("Output") produced over the same operating and/or historical period by using appropriate and auditable measurement procedures and records acceptable to the Utility, NJ BRC Staff, and Rate Counsel, or to the NJ BRC. Output is intended to include units of production, volume of input materials, tons of cooling, gallons of fluid processed, sales units, or other units directly related to the energy use of the system affected by the efficiency measure.

b. Develop Load Curves:

   i. Develop a Load Curve that reflects Pre- and, where applicable, Post-Installation kW versus Output relationship. This curve can be developed based upon a regression analysis using acceptable historical data and/or operating measurements subject to Paragraph 2.b.iii below. This Load Curve will be used to establish baseline electrical consumption for savings calculations.

   ii. Use of Load Curves are appropriate only where there is no significant change in the process from which the Load Curve was derived.

iii. When regression analysis is used for developing the Load Curve, the intervals of data should be selected to match the practical operation of the end use or process being evaluated. In general, hourly data can and should be used to evaluate end uses such as chillers, lighting, water heating, etc. since the output of the system coincides with the electric input to the system.

However, certain processes involve production cycles such that the hourly output of the system significantly lags energy input, and/or has little or no relation to hourly input. For example, a production cycle for a batch process may involve a warm-up, production, cool down and clean-up/preparation cycle. The relationship between energy and output of such process is meaningful on a cycle basis.

Therefore, a modeling procedure should specifically test and justify the intervals of data to be used, based on descriptions of the operation of the facility or process, and the end uses involved. Hourly data is recognized as the standard where use of hourly data is: (a) practicable (measurement of hourly output can be obtained); and (b) meaningful based on the description of the production cycle or processes involved.

This model must be statistically valid in accordance with the following Regression Statistical Criteria:

1. Functional form of model is correct in the judgement of the Utility, NJ BRC and Rate Counsel (e.g., in terms of appropriate signs on parameters, use of proper variables, incorporation of only relevant variables, model limits and restrictions).

2. T-statistic for all estimated parameters in the model is at least 2 (90% confidence that the coefficient is not zero).

3. Allowance for known measurement errors, elapsed time over which data is gathered and data sources are clearly documented, and acceptable to the Utility, NJ BRC Staff, and Rate Counsel.

4. The model's correlation coefficient (R^2) is not less than 90%, unless otherwise accepted down to 80%.

5. Limits of the model used need to be specified.

c. After installation of the efficiency measure, compute the post-installation savings using one of the following methods, each of which supports the following computation of savings:

$$\text{kWh savings} = \sum_{i=1}^{n}[(kW_{Bi} - kW_{Ai}) * T_i]$$

Where:

	i	=	interval
	T_i	=	Hours in interval i
	n	=	Number of intervals
	kW_{Bi}	=	Baseline kW from Pre-Installation Load Curve corresponding to kW_{Ai}
	kW_{Ai}	=	Load after retrofit as determined under Option 1 or 2.

i. Option 1: Compare measured Post-Installation use with baseline Load Curve

A. Measure Output and electrical Input continuously over the life of claimed energy savings.

B. Compute savings as the difference in measured Post-Installation electrical input and the predicted values of the Pre-Installation Load Curves at the measured Post-Installation level of Output summed over the relevant Utility Time Period.

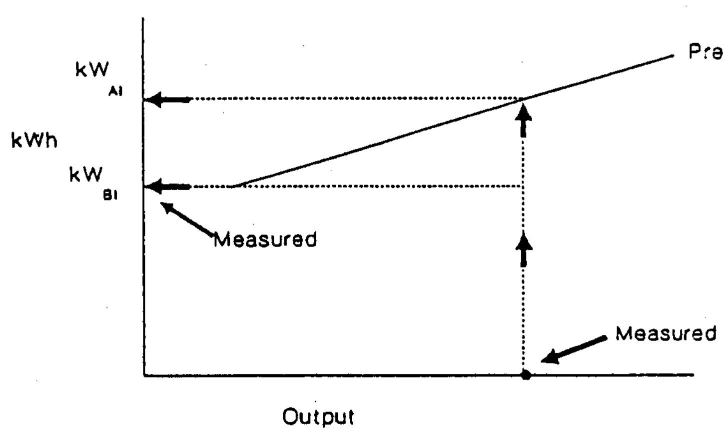
ii. Option 2: Establish Post-Installation Load Curve from measured results. (This Option 2 shall only be used on a case by case basis and only where there are specific reasons not to use Option 1 In addition, this Option 2 shall be used only after approval by the Utility, NJ BRC Staff and Rate Counsel, or by the NJ BRC.)

A. Measure electrical Input continuously over the life of claimed energy savings. Measure Output over the life of claimed energy savings and with sufficient frequency and duration to establish acceptable Load Curves pursuant to Steps 2.a and 2.b above.

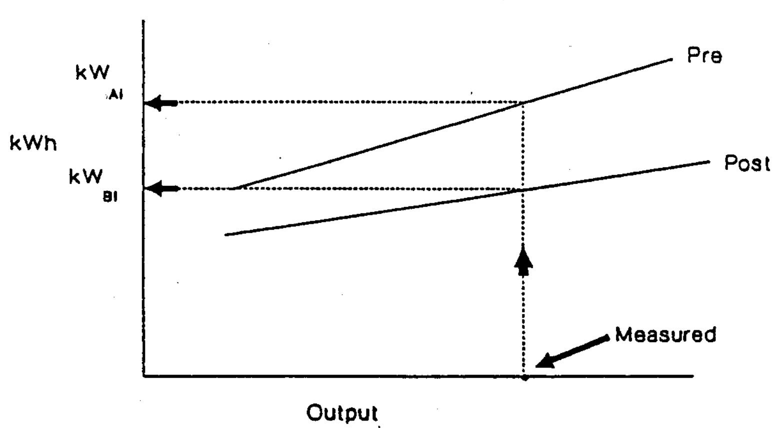
B. Repeat Steps 2.a.i and 2.a.ii, and develop a Post-Installation Load Curve each year of a form identical to the Pre-Installation Load Curve from the post-installation measured data. Repeat this Step annually throughout the duration of the agreement with the Utility and/or the customer and use this relationship for calculating savings for the annual period for which the Post-Installation Load Curve was developed.

C. Compute savings as the difference in predicted values of the Pre- and Post-Installation Load Curves at the measured Post-Installation level of kW summed over the relevant Utility Time Period.

Option 1



Option 2



For both Option 1 and Option 2, the measurement steps above will be available for review by the Utility, NJ BRC Staff and Rate Counsel. Also, customer will provide a statement indicating that the measurements are of representative conditions and/or are over a typical operating range.

d. Other issues related to measurement under this Method 3 are as follows:

i. Where sampling of devices or circuits are involved, such sampling shall be done in accordance with the Utility's Sampling Plan.

ii. Where run-hours are metered, the intent is to record hours of use for all applicable Utility Time Periods. While this Method 3, and the referenced examples in Appendix D, may refer to on-peak and off-peak hours, a Utility may utilize different time periods (e.g., intermediate peak) or divide the peak time into various categories or windows (e.g., seasonal peaks). The methodologies set forth in this Method 3 are intended to apply identically to these other time periods.

iii. Metering alternatives shall, subject to the Utility's Verification Procedures, be capable of seasonally differentiated time metering and of registering on-peak and off-peak hours of operation, or other Utility Time Periods appropriate to a Utility's rate or incentive valuation structure.

Metering shall be accessible and capable of being audited by the Utility. If computerized metering equipment is used, it must be accessible remotely through a modem and capable of being audited by the Utility. In addition, a metering plan shall be required for each facility setting forth which circuits or motors are to be measured consistent with a Utility's Sampling Plan.

iv. If required by a Utility's Verification Procedures, the measurement steps above will be conducted in the presence of, and recording data will be made available for review by NJ BRC Staff, Utility representative or Rate Counsel.

v. Improved efficiencies of electric end-use loads may vary due to effects of weather. Where such effects are to be calculated, the system performance curves and savings computation procedures will require modification. Specific measurement methodologies involving adjustments due to weather will be presented for consideration on a case-by-case basis to the Utility, NJ BRC Staff and Rate Counsel.

3. Duration of Measurements

The duration of measurement required pursuant to this Method 3 shall be determined for each measure application on a case-by-case basis depending on the specific characteristics of the system or process addressed. In general, duration will range from: (a) a minimum of the cycle time over which the device affected by the measure is subjected to the full range of variable loads typical for the process with which the device is associated; and (b) a maximum of one year. Unless otherwise approved, where there is one measurement of output per cycle, a minimum of 30 cycles shall be used. For each host facility, a proposed duration of measurement plan will be submitted to the Utility for review and approval, and then to NJ BRC Staff and Rate Counsel for their approval, prior to proceeding with measure implementation. Post-installation measurement will continue for the life of the benefits claimed.

4. Example Applications

Examples setting forth or illustrating the application of this Method 3 are presented in Appendix D, Examples 1 through 5. Additional examples may be attached hereto once approved by the Utility, NJ BRC Staff and Rate Counsel, or by the NJ BRC, as set forth in the Overview to this Protocol.

The measurement methodologies discussed in this Method 3 and the referenced examples in Appendix D shall be applied only to measures for which units of output are currently or capable of being quantified. Specific examples are provided as Appendix D of this Measurement Protocol in order to aid in the interpretation and application of this method under certain circumstances and conditions.

If required, the output measurement approach proposed for use with each measure application will be submitted to Utility for its review and approval. Prior to proceeding with measure implementation, the output measurement approach will be submitted to NJ BRC and Rate Counsel for final review and approval. Also, the end-use customer will provide a statement indicating that the measurements are of representative conditions and/or are over a typical operating range.

D. METHOD 4: OTHER TECHNOLOGY SPECIFIC MEASUREMENT METHODOLOGIES

METHOD 4A: THERMAL STORAGE

1. Types of Measures

Method 4A applies solely for cooling thermal storage technologies (TES) where the TES system replaces or supplements an existing or new space cooling system. The principles of the measurement methodology set forth in this Method 4A may require adaptation to specific applications.

2. Measurement Methodology

The measurement methodology for TES is as follows:

a. Measure Tons and Ton-Hours

Measure tons and ton-hours in and out of storage to measure energy shifted from on-peak hours and average cooling load deferred by storage. (The conversion of cooling demand and energy in tons or ton-hours to electrical demand or energy is developed below in Paragraph 2.b). To provide these measurements, a number of points must be monitored and recorded continuously. Figure 1 shows these measurement points for a typical system. A range of system designs and possible metering configurations are anticipated, which will require technical adaptations of the principles expressed in this methodology.

i. To measure hourly thermal load shifted from storage (ton-hours/hours) during the applicable Utility Time Period, use the following equations:

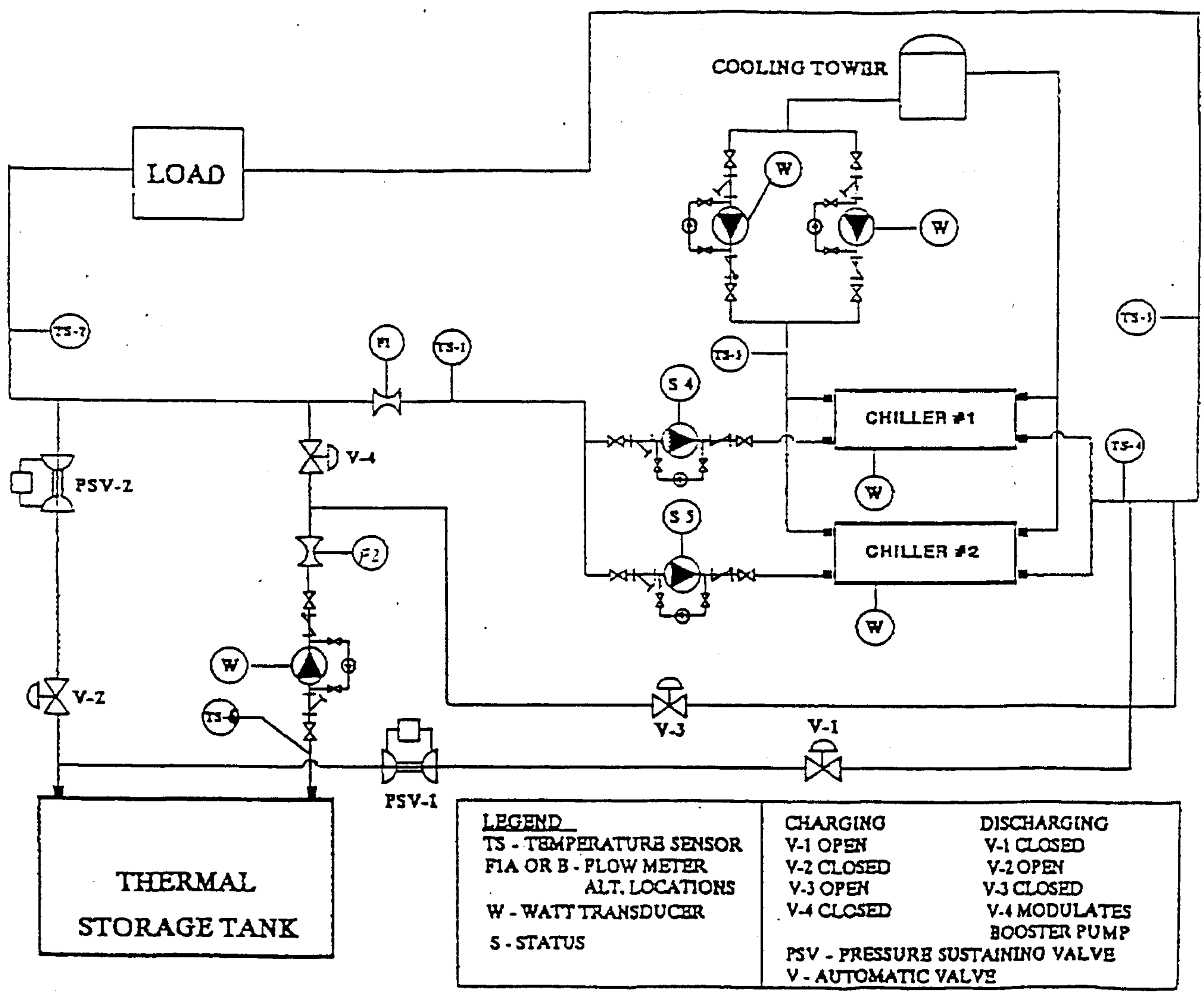
$$\text{tonnage from storage} = \frac{(T2 - T1) * F1 * 500}{12{,}000}$$

or

$$\frac{(T2 - T6) * F2 * 500}{12{,}000}$$

ii. To measure Utility Time Period cooling to or from storage, use the equation set forth in Paragraph 2.a.i integrated over time.

Figure 1: Measurement Points for a Typical Cool Storage System



iii. To measure energy used to charge the storage tank (ton-hours/hours), use the following equation integrated over time:

$$\frac{(T6 - T4) * F2 * 500}{12{,}000}$$

iv. To measure building load (tons), use the following equation:

$$\frac{(T2 - T3) * F1 * 500}{12{,}000}$$

v. To measure chiller load (tons) use the following equation:

$$\frac{(T1 - T4) * F1 * 500}{12{,}000}$$

vii. The definitions of the terms in the formulae set forth in this Paragraph 2 are as follows:

T1	=	Chilled water return temperature before chiller
T2	=	Chilled water return temperature off of the building load
T3	=	Chilled water supply temperature
T4	=	Chilled water supply temperature out of the chiller(s)
T5	=	Condenser water return temperature
T6	=	Water temperature out of storage
F1	=	System flow rate (GPM)
F2	=	Flow rate (GPM) from storage
500	=	a constant that converts GPM and change in temperature to btuh, as follows: $\frac{1\ \text{Btu/lb.}}{°\text{F}} * \frac{8.33\ \text{lbs. of H2O}}{\text{Gal.}} * \frac{60\ \text{min.}}{\text{Hr.}}$
12,000	=	a constant that converts btu's to ton-hours (12,000 btu's per ton-hour)

Note that these basic conversions do not include energy of pumps and fans, which are accounted for in Paragraph 2.b below.

b. Conversion of Tons/Ton-Hours to kW/kWh

Demand reduction from thermal storage discharge shall be the average of the hourly differences between Measured Cooling Demands (kWm), and Simulated Cooling Demands during the applicable capacity period.

i. Measured Cooling Demand is the actual electrical cooling demand during the applicable capacity period and is comprised of chiller kW, cooling tower fans, condenser water pumps, and storage booster pumps, and is reflected by the following formula:

kWm = (Chiller kW) + (Cooling tower fans kW) + (Condenser water pump kW) + (Storage booster pump kW)

ii. Simulated Cooling Demand is an estimate of total cooling electrical demand in absence of storage. Measured system performance under actual operating conditions shall provide the basis for estimation routines. Simulated performance shall be based on measured operating conditions over the billing period, specifically total building cooling load (Paragraph 2.b.iv), chiller discharge temperature (T4), condenser temperatures (T5) and percentage of chiller loading. The procedures for developing such projections are outlined below.

Energy use for charging or discharging thermal storage discharge during the applicable Utility Time Periods shall be the integrated hourly differences between Measured Cooling Demands and Simulated Cooling Demand during the Utility Time Period.

c. Determination of Simulated Cooling Demand

i. Chiller Performance Curve

It is recognized that the chiller kW usage will vary based on percentage loading, entering condenser water temperature, and chiller supply temperatures.

To determine chiller kW from chiller tons, a "field developed" chiller specific performance curve shall be used. Given input variables for this curve include entering condenser water temperature and percentage chiller loading. In addition, if chilled supply temperatures are to be varied by more than 5° F from 45° F, chiller supply temperatures should also be included in the development of the performance curve.

For example, a performance curve of a McQuay centrifugal chiller is set forth below. This curve was supplied by McQuay in its product literature. As part of this example, assume that a 500 ton chiller's rated efficiency at 100% load and at 85° F entering condenser water temperature is 0.75 kW/ton. At a given point in time, the chiller is assumed to be running at 300 tons and 75° F entering condenser water temperature. Based on this graph, the chiller kW usage will be at 53% of its rated kW draw, or:

500 tons * .75 kW/ton * 53% = 199 kW

ii. <u>Storage Operation</u>

The chiller's tonnage output and operating conditions will be measured directly and applied to the actual operation of the system with storage. This field data, applied to the chiller performance curve, will establish actual kW and kWh usage by the chiller with storage in operation.

iii. <u>Non-Storage (Simulated) Operation</u>

Under the conventional, non-storage operation, the chiller would be operated to meet the building load directly with entering condenser water temperatures at the time the load occurs. Thus, to calculate the chiller kW usage for the non-storage (simulated) condition, the input variables will be the building load in tons and the ambient condenser water temperature. This data will be applied to the chiller performance curve to establish chiller kW for the non-storage, simulated condition.

Chiller Performance Curve

EER

EER is the acronym for Energy Efficient Ratio. Its value may be determined from any of the following formulas:

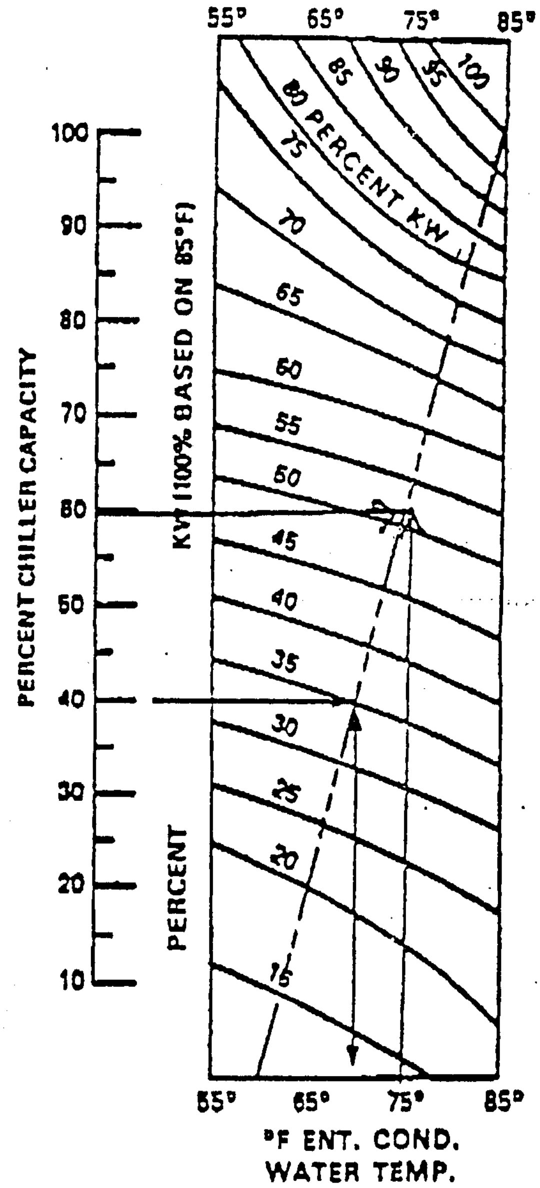
$$EER = \frac{BTUH}{Watts} = \frac{Tons \times 12}{kW} = \frac{12}{kW\ Per\ Ton}$$

Part load performance

Annual part load performance can usually best be determined by computer evaluation.

The maintained refrigerant pure atmosphere characteristic of R-12 refrigerant, thermostatic expansion valve control, and a sensitive, close tolerance temperature controller used in conjunction with hydraulically operated compressor airfoil inlet vanes make part load performance of McQuay centrifugal chillers readily predictable. For these reasons, the accompanying curve is offered to provide percentage of peak load kW at varying percentages of capacity and entering condenser water temperatures. With this data, and estimated operating hours at various capacities, the designer may estimate annual operating power for alternate selections. This curve is based on average performance over all frame sizes.

Computer evaluation programs are available for specific applications and machine selections.



iv. Measurement Points Required

The input data points required to determine chiller tonnage output from the chiller performance curve are as follows:

- Chilled water temperatures in and out of the chiller(s).
- System flow rate through the chiller(s).
- Entering (return) condenser water temperature.
- Ambient air temperature and relative humidity.

To develop the chiller performance curve (as described below), the following additional point(s) will be required:

- kW for chiller, pumps and cooling tower fans (see Paragraph 2.c.viii)

v. Development of Chiller Performance Curve

In order to develop the chiller performance curve, a continuous monitoring procedure will be used to measure the chiller performance for the range of operating conditions expected to occur during the life of the agreed upon performance period. The chiller's actual kW consumption will be measured against its tonnage output under different operating conditions, based on various percentage loadings and the range of expected entering condenser water temperatures. Chilled water temperatures in and out of the chiller, chilled water flow rate, and condenser water temperatures, versus chiller kW consumption, over the range of operating conditions shall be measured in order to empirically develop the performance curve.

The establishment of the chiller performance curve through field test data will be conducted initially during the first year after the installation dates and will be repeated periodically over the course of the agreed-upon performance period as required by the Utility's measurement plan.

vi. Interim Performance Curve

During the first year of operation, interim performance curves will be used for billing purposes, the interim curve will be based on the data collected after the installation date for purposes of establishing the final performance curve. An interim curve will be submitted with the monthly billing information as well as data used to develop it. After one year of operation, a finalized chiller performance curve will be presented to Utility, and used thereafter. A true-up adjustment will be made to the first year of operation based on any differences between the final field developed performance curve and interim curves used during the first year for billing purposes.

vii. New Chiller

Where an existing chiller is modified or replaced, both the old and the new chillers will be measured. A chiller performance curve will have already been established for the old chiller based on a test designed to run the chiller over a full range of operating conditions and utilizing measurement points described in Step iv. above. Interim and final performance curves will be established for the new chiller based on the procedure described in Steps iv. and v. above. Chiller kW for the storage operation will be based on the measured electric input to the new chiller, whereas chiller kW for the conventional simulated condition will be based on the old chiller performance curve.

viii. Auxiliaries

In order to more accurately measure the impact of cool storage, the operation of the condenser water pump, the cooling tower fans, the chiller pumps, and the new tank booster pump will be monitored and recorded. With the exception of the existing chilled water pumps, the operation of each of these auxiliary devices will be measured and recorded with a power monitoring transducer.

Also, these auxiliaries will typically cycle on and off in response to the load. Continuous monitoring will account for such cycling operation. It will also be necessary to extend certain cycling assumptions to the base case (no storage) calculations. These assumptions will be based on actual control logic used during the storage operating conditions to cycle the cooling tower fans and condenser pump (e.g., ambient temperatures and percentage load.) Such control logic and assumptions shall be submitted for review and approval by the Utility, NJ BRC Staff, and Rate Counsel, or by the NJ BRC, prior to its application.

Also, a watt transducer will be placed on the storage tank booster pump and continuously monitored in order to account for its operation, including the varying flow rates that will alter its power consumption.

d. Example Applications

Examples setting forth or illustrating the application of this Method 4A are presented in Appendix E, Example 1. Additional examples may be attached hereto once approved by the Utility, NJ BRC Staff and Rate Counsel, or by the NJ BRC, as set forth in the Overview to this Protocol.

METHOD 4B: HEAT RECOVERY

1. Types of Measures

Numerous technologies and opportunities exist which recycle "waste heat" rather than rejecting it. Some examples include:

- Ventilation Air Heat Recovery: Systems use crossflow heat exchangers, heat wheels, run-around systems, vapor compression systems, or others to capture the sensible (and sometimes latent) heat from exhaust air to precondition supply ventilation air, reducing heating and/or cooling loads. This is of particular importance with new requirements for ventilation air.

- Vapor Compression Heat Reclaim: Heat normally removed by air conditioning or refrigeration systems and rejected to the atmosphere via condensers or cooling towers is used to heat water or provide space conditioning.

- Waste Water Heat Recovery: Rejected waste water may provide a free source of heat such as for pre-heating domestic hot water supply or other end uses.

- Process Heat Recovery: Detailed review of industrial production cycles can reveal independent heating and cooling processes which can serve as heat sources/sinks for each other provided the appropriate equipment and controls.

2. Measurement Methodology

The Utilities and ESCO's shall work together to develop a measurement methodology for measuring heat recovery technologies that they will submit to NJ BRC Staff and Rate Counsel for review and, if acceptable, approval.

[This page intentionally left blank.]

III. MEASUREMENT AND VERIFICATION FOR WHOLE HOUSE WEATHERIZATION PROGRAMS FOR EXISTING RESIDENCES

This methodology is based on billing data analysis and is applicable only to programs addressing space heating or cooling and other uses of the same energy source. It can be applied to programs which impact home energy consuming systems combined with weatherization but cannot be used in such programs as a lighting replacement done by itself.

This methodology provides guidelines for measuring and verifying whole house weatherization programs. It is the responsibility of each Utility to propose to the NJ BRC Staff and Rate Counsel for review and approval, a specific detailed plan for measurement of Whole House Weatherization programs.

A. General Guidelines

Measurement and verification shall be based on billing record analysis. Savings for a residence will be the difference between base period use, pre retrofit, and post retrofit use, as adjusted by the use of a control group.

The measurement and verification procedure shall include all foreseeable decision rules, i.e., be as fully specified as possible, to prevent the need for post hoc rationalizations and/or disagreements regarding the value of measured savings. Treatment of situations such as vacancies and changes in building use can be dealt with explicitly and by the use of a control group. If any explicit adjustments are to be used they shall be pre approved in the Utility's measurement and verification plan.

If a Utility deems it necessary to include any explicit adjustments (such as vacancies, change in building use, weather, etc.), these adjustments should be specified in its measurement and verification plan. In addition to any requested adjustments, the plan should specifically address the following general issues:

1) Inspections;
2) Design of control group;
3) Length of base and post treatment period;
4) Capacity savings; and
5) Allocation of savings to Utility Time Periods.

B. Weather Adjustment

If weather adjustment is used it shall be made by regressing the individual residence usage for the period (base period or measurement year) against heating and cooling degree days to a fixed base. The regression model used should account for statistically valid heating and cooling weather sensitivities.

The monthly or (bimonthly) usage data will be correctly matched with the weather data associated with each customers billing cycle (as opposed to calendar month weather data) to improve accuracy.

To lend consistency and precision to the use of regressions, the statistical criteria for model acceptance and rejection, data editing procedures (to correct measurement error only), and all the decision rules to be used in the measurement process will be pre-specified in the plan.

C. Length of Base and Post Treatment Period

In general, as long a base period as practicable, not less than twelve months, should be used. Measurement will continue for the life of claimed savings for each treated residence, using succession customers as needed in both the treated and control groups.

A long base period is preferable to eliminate short term externalities that may or may not be adequately captured by the control group and to improve the weather adjustment procedures. The base period for any customer will include all data up to five years of that customer's usage. Each Utility maintains different depth of usage history on line, and not all have yet developed procedures to access and compile archive records to provide a full five year history readily.

If the customer has not been at that location for the entire base period, the entire history for that customer will be used plus predecessor data. A specific Utility plan may omit the use of predecessor data until data processing capabilities are sufficient to permit this.

D. Design of the Control Group

Different approaches to the selection of a control group may be proposed. The ideal control group would be statistically comparable to the treated group. The most practical and important comparison characteristic for purposes of impact evaluation are housing type, size and energy usage. Secondary characteristics are occupant demographics (including economic, occupancy and behavior characteristics) and micro climate.

While the ideal control group is a random selection of the population, most Utilities have indicated that services should not be withheld from any eligible customer making control group attrition an issue. The "house next door" technique is one option for use in selecting a control group. This approach takes advantage of Utility meter routes, presuming comparability of homes within a neighborhood, and allows the initial control group size to equal the treated group size.

Another approach involves use of a large group of customers from a cross-section of the program's target market. Use of a large sample allows attrition due to participation in the program, or other prescribed causes. Any control group must be initially larger than needed to allow for attrition over time.

A third approach relies on "clusters" of demographic variables. Each census tract falls into a specific demographic cluster group. Each treated residence (or group of residences) is matched with a control group home which is in the same demographic cluster.

E. Other Adjustments

Where any editing (as defined above), or decision rules with respect to the use or treatment of customer billing data will be made, specific decision rules will be prespecified. The NJ BRC generally supports little or no use of such decision rules in the plan, in that equivalent "disruptions" should be expected to occur in the treated and control groups. Any use of such decision rules should apply equally to the treated and control groups.

Possible events requiring explicit decision rules are limited to vacancies, change in facility use (residential to commercial conversion), material changes in use, space or water heat energy source conversion, and service termination.

F. Capacity Savings

Where capacity savings need to be decided, it may be calculated from the measured seasonal energy savings, and the seasonal class average load factor, as determined from class load research data.

G. Savings Allocation to Utility Time Period

If savings values vary by season, metered data must be proposed for allocating measured savings to Utility Time Periods.

IV. APPENDICES

APPENDIX A: TECHNICAL EXHIBITS

APPENDIX A, EXHIBIT 1

LUMINAIRE TABLES

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
001-001	INCANDESCENTS	20W INCANDESCENT	N/A	N/A		20	20	
003-001	INCANDESCENTS	25W INCANDESCENT	N/A	N/A		25	25	
004-001	INCANDESCENTS	30W INCANDESCENT	N/A	N/A		30	30	
005-001	INCANDESCENTS	34W INCANDESCENT	N/A	N/A		34	34	
007-001	INCANDESCENTS	36W INCANDESCENT	N/A	N/A		36	36	
009-001	INCANDESCENTS	40W INCANDESCENT	N/A	N/A		40	40	
011-001	INCANDESCENTS	42W INCANDESCENT	N/A	N/A		42	42	
013-001	INCANDESCENTS	45W INCANDESCENT	N/A	N/A		45	45	
015-001	INCANDESCENTS	50W INCANDESCENT	N/A	N/A		50	50	
017-001	INCANDESCENTS	52W INCANDESCENT	N/A	N/A		52	52	
019-001	INCANDESCENTS	55W INCANDESCENT	N/A	N/A		55	55	
021-001	INCANDESCENTS	60W INCANDESCENT	N/A	N/A		60	60	
023-001	INCANDESCENTS	65W INCANDESCENT	N/A	N/A		65	65	
025-001	INCANDESCENTS	67W INCANDESCENT	N/A	N/A		67	67	
026-001	INCANDESCENTS	69W INCANDESCENT	N/A	N/A		69	69	
027-001	INCANDESCENTS	72W INCANDESCENT	N/A	N/A		72	72	
029-001	INCANDESCENTS	75W INCANDESCENT	N/A	N/A		75	75	
031-001	INCANDESCENTS	80W INCANDESCENT	N/A	N/A		80	80	
033-001	INCANDESCENTS	85W INCANDESCENT	N/A	N/A		85	85	
035-001	INCANDESCENTS	90W INCANDESCENT	N/A	N/A		90	90	
037-001	INCANDESCENTS	100W INCANDESCENT	N/A	N/A		100	100	
039-001	INCANDESCENTS	120W INCANDESCENT	N/A	N/A		120	120	
041-001	INCANDESCENTS	125W INCANDESCENT	N/A	N/A		125	125	
043-001	INCANDESCENTS	135W INCANDESCENT	N/A	N/A		135	135	
045-001	INCANDESCENTS	150W INCANDESCENT	N/A	N/A		150	150	
047-001	INCANDESCENTS	200W INCANDESCENT	N/A	N/A		200	200	
048-001	INCANDESCENTS	250W INCANDESCENT	N/A	N/A		250	250	
049-001	INCANDESCENTS	300W INCANDESCENT	N/A	N/A		300	300	
051-001	INCANDESCENTS	500W INCANDESCENT	N/A	N/A		500	500	
053-001	INCANDESCENTS	750W INCANDESCENT	N/A	N/A		750	750	
055-001	INCANDESCENTS	1000W INCANDESCENT	N/A	N/A		1000	1000	
057-001	INCANDESCENTS	1500W INCANDESCENT	N/A	N/A		1500	1500	
061-001	INCANDESCENTS	50W QUARTZ	N/A	N/A		50	50	
063-001	INCANDESCENTS	75W QUARTZ	N/A	N/A		75	75	
065-001	INCANDESCENTS	100W QUARTZ	N/A	N/A		100	100	
067-001	INCANDESCENTS	150W QUARTZ	N/A	N/A		150	150	
069-001	INCANDESCENTS	200W QUARTZ	N/A	N/A		200	200	
071-001	INCANDESCENTS	250W QUARTZ	N/A	N/A		250	250	
073-001	INCANDESCENTS	300W QUARTZ	N/A	N/A		300	300	
075-001	INCANDESCENTS	350W QUARTZ	N/A	N/A		350	350	
077-001	INCANDESCENTS	400W QUARTZ	N/A	N/A		400	400	
079-001	INCANDESCENTS	425W QUARTZ	N/A	N/A		425	425	
081-001	INCANDESCENTS	500W QUARTZ	N/A	N/A		500	500	
083-001	INCANDESCENTS	750W QUARTZ	N/A	N/A		750	750	
085-001	INCANDESCENTS	900W QUARTZ	N/A	N/A		900	900	
087-001	INCANDESCENTS	1000W QUARTZ	N/A	N/A		1000	1000	
089-001	INCANDESCENTS	1500W QUARTZ	N/A	N/A		1500	1500	
100-001	COMPACT FLUORESCENT	5W CF/SI	N/A	N/A		7	7	
100-001	COMPACT FLUORESCENT	5W CF/SI	EASTROCK	AC-5	29	7	7	
100-001	COMPACT FLUORESCENT	5W CF/SI	PHILIPS LGTG	PL-S 5/27/SYS	14	7	7	
5-001	COMPACT FLUORESCENT	5W CF/HW	N/A	N/A		7	7	
110-001	COMPACT FLUORESCENT	7W CF/SI	N/A	N/A		10	10	
110-001	COMPACT FLUORESCENT	7W CF/SI	EASTROCK	AC-7	26	10	11	-10.00%

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
110-001	COMPACT FLUORESCENT	7W CF/SI	PHILIPS LGTG	PL-S 7W/27/SYS	16	10	10	
113-001	COMPACT FLUORESCENT	7W CF/SI INT	N/A	N/A		7	7	
113-001	COMPACT FLUORESCENT	7W CF/SI INT	OSRAM CORP	DB010	16	7	7	
115-001	COMPACT FLUORESCENT	7W CF/HW	N/A	N/A		10	10	
120-001	COMPACT FLUORESCENT	9W CF/SI	N/A	N/A		11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	EASTROCK	AC-9	23	11	10	9.09%
120-001	COMPACT FLUORESCENT	9W CF/SI	ENERTRON	3500-L	10	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	ENERTRON	3600-L	10	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	ENERTRON	4500-L	12	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	ENERTRON	4600-L	12	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	ENERTRON	3500 HPF-L	10	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	ENERTRON	3600 HPF-L	10	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	ENERTRON	3500-HPF-L	10	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	ENERTRON	3600-HPF-L	10	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	FIET ELECT	MLPL-9	13	11	13	-18.18%
120-001	COMPACT FLUORESCENT	9W CF/SI	LUMATECH	10923	13	11	10	9.09%
120-001	COMPACT FLUORESCENT	9W CF/SI	LUMATECH	10924	13	11	10	9.09%
120-001	COMPACT FLUORESCENT	9W CF/SI	LUMATECH	10925	13	11	10	9.09%
120-001	COMPACT FLUORESCENT	9W CF/SI	PHILIPS LGTG	PL-S 9W/27/SYS	16	11	12	-9.09%
120-001	COMPACT FLUORESCENT	9W CF/SI	PROLIGHT	209	11	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	PROLIGHT	209-HPF	17	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	PROLIGHT	309	12	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	PROLIGHT	409	11	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	PROLIGHT	409-HPF	17	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	PROLIGHT	509	11	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	PROLIGHT	709	11	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	PROLIGHT	809	11	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	PROLIGHT	TL9	11	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	PROLIGHT	759-HPF	11	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	PROLIGHT	759 HPF	11	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	TEK-TRON	E O9R-N	12	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	TEK-TRON	EO9R-N	13	11	11	
120-001	COMPACT FLUORESCENT	9W CF/SI	VALMONT	6G1079	29	11	11	
120-002	COMPACT FLUORESCENT	9W CF/SI - LO	N/A	N/A		14	14	
120-002	COMPACT FLUORESCENT	9W CF/SI - LO	VALMONT	6G3366		14	14	
125-001	COMPACT FLUORESCENT	9W CF/HW	N/A	N/A		11	11	
130-001	COMPACT FLUORESCENT	11W CF/SI	N/A	N/A		13	13	
133-001	COMPACT FLUORESCENT	11W CF/SI INT	N/A	N/A		11	11	
133-001 NE	COMPACT FLUORESCENT	11W CF/SI INT	OSRAM CORP	DB060	124	11	11	
133-001 NE	COMPACT FLUORESCENT	11W CF/SI INT	OSRAM CORP	DBO20	124	11	11	
133-001 NE	COMPACT FLUORESCENT	11W CF/SI INT	OSRAM CORP	DBO70	124	11	11	
135-001	COMPACT FLUORESCENT	11W CF/HW	N/A	N/A		13	13	
140-001	COMPACT FLUORESCENT	13W CF/SI	N/A	N/A		15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	EASTROCK	AC-13	15	15	16	-6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	EASTROCK	NN13-R3O	15	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	EASTROCK	NN13-R40	15	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	EASTROCK	RF SQ-13	15	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	ENERTRON	2000-L	12	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	ENERTRON	3800-L	11	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	ENERTRON	4700-L	16	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	ENERTRON	4800-L	16	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	ENERTRON	3800-HPF-L	11	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	ENERTRON	3700-HPF-L	16	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	FIET ELECT	MLPL-13	11	15	17	-13.33%

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
140-001	COMPACT FLUORESCENT	13W CF/SI	FIET ELECT	PLD-13ER	17	15	17	-13.33%
140-001	COMPACT FLUORESCENT	13W CF/SI	FIET ELECT	PLD-13PAR	16	15	17	-13.33%
140-001	COMPACT FLUORESCENT	13W CF/SI	LUMATECH	11323	12	15	14	6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	LUMATECH	11324	12	15	14	6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	LUMATECH	11325	12	15	14	6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	LUMATECH	11326	12	15	14	6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	PHILIPS LGTG	PL-C 13W/27/SYS		15	14	6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	213	11	15	16	-6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	213-HPF	18	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	313	11	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	413	11	15	16	-6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	413-HPF	18	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	513	11	15	16	-6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	636-QL13-W	11	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	713	11	15	16	-6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	753	18	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	813	11	15	16	-6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	G36-QL13-W	11	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	T24-QL13-C	11	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	T24-QL13-W	11	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	PROLIGHT	TL13	11	15	16	-6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	TEK-TRON	10013	9	15	14	6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	TEK-TRON	E 13R-H	27	15	15	
140-001	COMPACT FLUORESCENT	13W CF/SI	TEK-TRON	E 13R-N	13	15	16	-6.67%
140-001	COMPACT FLUORESCENT	13W CF/SI	TERON	RFL-L213Q-R30		15	17	-13.33%
140-001	COMPACT FLUORESCENT	13W CF/SI	TERON	RFL-L213Q-R30		15	17	-13.33%
0-001	COMPACT FLUORESCENT	13W CF/SI	VALMONT	6G1013G03		15	17	-13.33%
145-001	COMPACT FLUORESCENT	13W CF/HW	N/A	N/A		15	15	
153-001	COMPACT FLUORESCENT	15W CF/SI INT	N/A	N/A		15	15	
153-001	COMPACT FLUORESCENT	15W CF/SI INT	MATSUSHITA	BFG15LE/A-C		15	15	
153-001	COMPACT FLUORESCENT	15W CF/SI INT	MATSUSHITA	BFT15EX/T-C		15	15	
153-001	COMPACT FLUORESCENT	15W CF/SI INT	MATSUSHITA	BFT15LE/T-C		15	15	
153-001 NE	COMPACT FLUORESCENT	15W CF/SI INT	OSRAM CORP	DB030	148	15	15	
153-001 NE	COMPACT FLUORESCENT	15W CF/SI INT	OSRAM CORP	DB065	148	15	15	
153-001 NE	COMPACT FLUORESCENT	15W CF/SI INT	OSRAM CORP	DB072	148	15	15	
153-001 NE	COMPACT FLUORESCENT	15W CF/SI INT	PHILIPS LGTG	SLS*15	130	15	15	
153-001	COMPACT FLUORESCENT	15W CF/SI INT	SYLVANIA	BFT-15	18	15	15	
156-001	COMPACT FLUORESCENT	16W CF/SI INT	N/A	N/A		16	16	
157-001	COMPACT FLUORESCENT	17W CF/SI INT	N/A	N/A		17	17	
157-001 NE	COMPACT FLUORESCENT	17W CF/SI INT	PHILIPS LGTG	SLS*17	129	17	17	
160-001	COMPACT FLUORESCENT	18W CF/SI	N/A	N/A		21	21	
160-001	COMPACT FLUORESCENT	18W CF/SI	FIET ELECT	ESL-18	12	21	21	
160-001	COMPACT FLUORESCENT	18W CF/SI	FIET ELECT	ESL-18R	12	21	21	
162-001	COMPACT FLUORESCENT	(2) 18W QD/ELEC	N/A	N/A		38	38	
162-001	COMPACT FLUORESCENT	(2) 18W QD/ELEC	EBT	SSB6277218LH	15	38	38	
163-001	COMPACT FLUORESCENT	18W CF/SI INT	N/A	N/A		18	18	
163-001	COMPACT FLUORESCENT	18W CF/SI INT	MATSUSHITA	EFT18LE/T		18	18	
163-001 NE	COMPACT FLUORESCENT	18W CF/SI INT	PHILIPS LGTG	EARTH LT SL*18	117	18	18	
163-001	COMPACT FLUORESCENT	18W CF/SI INT	PHILIPS LGTG	SL*18/R40/27	16	18	18	
163-001 NE	COMPACT FLUORESCENT	18W CF/SI INT	SYLVANIA	FE18DTT/D827/MD	99	18	18	
165-001	COMPACT FLUORESCENT	20W CF/HW	N/A	N/A		22	22	
170-001	COMPACT FLUORESCENT	23W CF/SI	N/A	N/A		24	24	
-001	COMPACT FLUORESCENT	23W CF/SI	EASTROCK	AC-22	16	24	25	-4.17%
170-001	COMPACT FLUORESCENT	23W CF/SI	EASTROCK	AC-22	16	24	25	-4.17%

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
170-001	COMPACT FLUORESCENT	23W CF/SI	ENERTRON	3900-L	16	24	24	
170-001	COMPACT FLUORESCENT	23W CF/SI	ENERTRON	3900-HPF-L	16	24	24	
170-001 NE	COMPACT FLUORESCENT	23W CF/SI	FIET ELECT	ESL-22B	34	24	23	4.17%
170-001	COMPACT FLUORESCENT	23W CF/SI	FIET ELECT	ML-801	22	24	25	-4.17%
170-001	COMPACT FLUORESCENT	23W CF/SI	FIET ELECT	MLPL-22	15	24	25	-4.17%
170-001	COMPACT FLUORESCENT	23W CF/SI	PROLIGHT	1522	11	24	24	
170-001	COMPACT FLUORESCENT	23W CF/SI	PROLIGHT	222	11	24	24	
170-001	COMPACT FLUORESCENT	23W CF/SI	PROLIGHT	222-HPF	18	24	25	-4.17%
170-001	COMPACT FLUORESCENT	23W CF/SI	PROLIGHT	TL22Q	11	24	24	
170-001 NE	COMPACT FLUORESCENT	23W CF/SI	SYLVANIA	FE22DTT/D827/MD	99	24	22	8.33%
170-001	COMPACT FLUORESCENT	23W CF/SI	TEK-TRON	E 22R-H	25	24	23	4.17%
170-001	COMPACT FLUORESCENT	23W CF/SI	TEK-TRON	E 22R-N	13	24	25	-4.17%
180-001	COMPACT FLUORESCENT	26W CF/SI	N/A	N/A		28	28	
182-001	COMPACT FLUORESCENT	(2) 26W QD/ELEC	N/A	N/A		54	54	
182-001	COMPACT FLUORESCENT	(2) 26W QD/ELEC	EBT	SSB6120226LH	14	54	54	
185-001	COMPACT FLUORESCENT	26W CF/HW	N/A	N/A		28	28	
193-001	COMPACT FLUORESCENT	28W CF/SI INT	N/A	N/A		28	28	
193-001	COMPACT FLUORESCENT	28W CF/SI INT	PROLIGHT	1528	11	28	28	
193-001	COMPACT FLUORESCENT	28W CF/SI INT	TEK-TRON	10028	6	28	28	
193-001	COMPACT FLUORESCENT	28W CF/SI INT	TEK-TRON	10028-H	26	28	28	
195-001	COMPACT FLUORESCENT	28W CF/HW	N/A	N/A		30	30	
200-001	COMPACT FLUORESCENT	32W CF/HW	N/A	N/A		34	34	
205-001	COMPACT FLUORESCENT	44W CF/SI	N/A	N/A		44	44	
210-001	COMPACT FLUORESCENT	(2) 5W CF/HW	N/A	N/A		14	14	
215-001	COMPACT FLUORESCENT	(2) 7W CF/HW	N/A	N/A		18	18	
220-001	COMPACT FLUORESCENT	(2) 9W CF/HW	N/A	N/A		22	22	
225-001	COMPACT FLUORESCENT	(3) 9W CF/HW	N/A	N/A		33	33	
230-001	COMPACT FLUORESCENT	(2) 11W CF/HW	N/A	N/A		26	26	
235-001	COMPACT FLUORESCENT	(2) 13W CF/HW	N/A	N/A		30	30	
240-001	COMPACT FLUORESCENT	(3) 13W CF/HW	N/A	N/A		45	45	
245-001	COMPACT FLUORESCENT	22/32W CF/HW	N/A	N/A		60	60	
270-001	HALOGEN	42W HALOGEN	N/A	N/A		42	42	
272-001	HALOGEN	45W HALOGEN	N/A	N/A		45	45	
274-001	HALOGEN	52W HALOGEN	N/A	N/A		52	52	
276-001	HALOGEN	60W HALOGEN	N/A	N/A		60	60	
278-001	HALOGEN	72W HALOGEN	N/A	N/A		72	72	
280-001	HALOGEN	90W HALOGEN	N/A	N/A		90	90	
285-001	HALOGEN	20W LV HALOGEN	N/A	N/A		30	30	
287-001	HALOGEN	25W LV HALOGEN	N/A	N/A		35	35	
289-001	HALOGEN	35W LV HALOGEN	N/A	N/A		45	45	
291-001	HALOGEN	42W LV HALOGEN	N/A	N/A		52	52	
293-001	HALOGEN	50W LV HALOGEN	N/A	N/A		60	60	
295-001	HALOGEN	65W LV HALOGEN	N/A	N/A		75	75	
297-001	HALOGEN	75W LV HALOGEN	N/A	N/A		85	85	
300-001	EXIT SIGNS	INC. SUBMINI. EXIT	N/A	N/A		5	5	
305-001	EXIT SIGNS	5W PL EXIT	N/A	N/A		7	7	
310-001	EXIT SIGNS	8W PL EXIT	N/A	N/A		8	8	
320-001	EXIT SIGNS	7W PL EXIT	N/A	N/A		9	9	
325-001	EXIT SIGNS	10W PL EXIT	N/A	N/A		10	10	
330-001	EXIT SIGNS	4WT 5 FLUOR	N/A	N/A		11	11	
335-001	EXIT SIGNS	FLEXLITE EXIT SIGN	N/A	N/A		11	11	
340-001	EXIT SIGNS	6W T5 EXIT SIGN	N/A	N/A		13	13	

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
345-001	EXIT SIGNS	8W T5 EXIT SIGN	N/A	N/A		15	15	
350-001	EXIT SIGNS	15W EXIT	N/A	N/A		15	15	
355-001	EXIT SIGNS	13W PL EXIT	N/A	N/A		19	19	
360-001	EXIT SIGNS	20W 2L EXIT	N/A	N/A		40	40	
365-001	EXIT SIGNS	20W 1L EXIT	N/A	N/A		20	20	
370-001	EXIT SIGNS	13W T5 EXIT SIGN	N/A	N/A		25	25	
375-001	EXIT SIGNS	30W EXIT	N/A	N/A		30	30	
380-001	EXIT SIGNS	40W 1L EXIT	N/A	N/A		40	40	
401-001	T-12	1L4' STD/STD	N/A	N/A		57	57	
402-001	T-12	2L4' STD/STD	N/A	N/A		94	94	
403-001	T-12	3L4' STD/STD	N/A	N/A		151	151	
404-001	T-12	4L4' STD/STD	N/A	N/A		188	188	
406-001	T-12	1L4' STD/EEMAG	N/A	N/A		50	50	
406-001	T-12	1L4' STD/EEMAG	MAGNETEK	412-L-SLH-TC-P		50	53	-6.00%
406-001	T-12	1L4' STD/EEMAG	VALMONT	8G1074UW	18	50	49	2.00%
406-001	T-12	1L4' STD/EEMAG	VALMONT	8G1074W	19	50	48	4.00%
406-001	T-12	1L4' STD/EEMAG	VALMONT	8G1078W	20	50	48	4.00%
406-001	T-12	1L4' STD/EEMAG	VALMONT	8G1084UW	18	50	50	
406-001	T-12	1L4' STD/EEMAG	VALMONT	8G1084W	19	50	50	
406-001	T-12	1L4' STD/EEMAG	VALMONT	8G1088W	19	50	50	
407-001	T-12	2L4' STD/EEMAG	N/A	N/A		86	86	
407-001	T-12	2L4' STD/EEMAG	MAGNETEK	443-L-SLH-TC-P		86	87	-1.16%
07-001	T-12	2L4' STD/EEMAG	MAGNETEK	446-L-SLH-TC-P	14	86	85	1.16%
07-001	T-12	2L4' STD/EEMAG	VALMONT	8G1024W	17	86	85	1.16%
407-001	T-12	2L4' STD/EEMAG	VALMONT	8G1028W	14	86	89	-3.49%
407-001	T-12	2L4' STD/EEMAG	VALMONT	8G1034W	17	86	86	
407-001	T-12	2L4' STD/EEMAG	VALMONT	8G1038W	12	86	89	-3.49%
408-001	T-12	3L4' STD/EEMAG	N/A	N/A		136	136	
408-001	T-12	3L4' STD/EEMAG	MAGNETEK	721-L-VLH-TC-P		136	135	0.74%
409-001	T-12	4L4' STD/EEMAG	N/A	N/A		172	172	
411-001	T-12	1L4' STD/ELEC	N/A	N/A		37	37	
411-001	T-12	1L4' STD/ELEC	ADVANCE TR	VEL-IS40-RH-TP	17	37	36	2.70%
411-001	T-12	1L4' STD/ELEC	ADVANCE TR	VIC-140-TP	11	37	36	2.70%
411-001	T-12	1L4' STD/ELEC	EBT	SSB1120140LH	16	37	38	-2.70%
411-001	T-12	1L4' STD/ELEC	EBT	SSB1277140LH	16	37	38	-2.70%
411-001	T-12	1L4' STD/ELEC	MAGNETEK	B140T120RH	19	37	37	
411-001 NE	T-12	1L4' STD/ELEC	MAGNETEK	B140T277SRH	33	37	38	-2.70%
411-001	T-12	1L4' STD/ELEC	MAGNETEK	B140T277RH	16	37	38	-2.70%
411-001 NE	T-12	1L4' STD/ELEC	MAGNETEK	B140T120S	27	37	37	
411-001	T-12	1L4' STD/ELEC	VALMONT	E140SR120G01	14	37	35	5.41%
411-001	T-12	1L4' STD/ELEC	VALMONT	E140SR277G01	14	37	35	5.41%
411-001 NE	T-12	1L4' STD/ELEC	VALMONT	M28-277-I	23	37	45	-21.62%
412-001	T-12	2L4' STD/ELEC	N/A	N/A		71	71	
412-001	T-12	2L4' STD/ELEC	ADVANCE TR	REL-2S40-RH-TP	16	71	71	
2-001	T-12	2L4' STD/ELEC	ADVANCE TR	RIC-2S40-TP	6	71	72	-1.41%
412-001	T-12	2L4' STD/ELEC	ADVANCE TR	VEL-2S40-RH-TP	16	71	71	
412-001	T-12	2L4' STD/ELEC	ADVANCE TR	VIC-2S40-TP	12	71	72	-1.41%

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DI
412-001	T-12	2L4' STD/ELEC	EBT	SSB1120240LH	14	71	75	-5
412-001	T-12	2L4' STD/ELEC	EBT	SSB1277240LH	16	71	74	-4
412-001	T-12	2L4' STD/ELEC	EBT	SSB212040TTISL	15	71	66	7
412-001 NE	T-12	2L4' STD/ELEC	EBT	SSB2277240TTISL	67	71	67	5
412-001 NE	T-12	2L4' STD/ELEC	MAGNETEK	B24OR120	29	71	72	-1
412-001	T-12	2L4' STD/ELEC	MAGNETEK	B24OR120RH	18	71	72	-1
412-001 NE	T-12	2L4' STD/ELEC	MAGNETEK	B24OR277	25	71	74	-4
412-001	T-12	2L4' STD/ELEC	MAGNETEK	B24OR277HP	3	71	75	-5
412-001	T-12	2L4' STD/ELEC	MAGNETEK	B24OR277RH	18	71	74	-4
412-001 NE	T-12	2L4' STD/ELEC	MAGNETEK	B24OR1205	23	71	69	2
412-001	T-12	2L4' STD/ELEC	MAGNETEK	B240T120RH	17	71	70	1
412-001 NE	T-12	2L4' STD/ELEC	MAGNETEK	B240T277S	26	71	69	2
412-001	T-12	2L4' STD/ELEC	MAGNETEK	B240I277RH	17	71	70	1
412-001	T-12	2L4' STD/ELEC	MAGNETEK	B24OR120HP	6	71	71	
412-001	T-12	2L4' STD/ELEC	MOTOROLA	M2RN-T12-ILL120	5	71	74	-4
412-001	T-12	2L4' STD/ELEC	MOTOROLA	M2RN-T12-ILL277	4	71	74	-4
412-001	T-12	2L4' STD/ELEC	TMP	FLB40D120-6	9	71	72	-1
412-001	T-12	2L4' STD/ELEC	TMP	FLB40D277-6	9	71	74	-4
412-001	T-12	2L4' STD/ELEC	VALMONT	E240SR120G01	18	71	71	
412-001	T-12	2L4' STD/ELEC	VALMONT	E240SR277G01	15	71	71	
412-001	T-12	2L4' STD/ELEC	VALMONT	M28-120	16	71	71	
412-001	T-12	2L4' STD/ELEC	VALMONT	M28-277	17	71	71	
413-001	T-12	3L4' STD/ELEC	N/A	N/A		105	105	
413-001	T-12	3L4' STD/ELEC	ADVANCE TR	REL-3S40-RH-TP	18	105	109	-3
413-001	T-12	3L4' STD/ELEC	ADVANCE TR	RIC-3S40-TP	7	105	109	-3
413-001	T-12	3L4' STD/ELEC	ADVANCE TR	VEL-3S40-RH-TP	18	105	109	-3
413-001	T-12	3L4' STD/ELEC	ADVANCE TR	VIC-3S40-TP	14	105	104	0.
413-001	T-12	3L4' STD/ELEC	EBT	SSB1277340LH	14	105	109	-3.
413-001	T-12	3L4' STD/ELEC	EBT	SSB2120340TTISL	15	105	101	3.
413-001	T-12	3L4' STD/ELEC	EBT	SSB2277340TTISL	16	105	102	2.
413-001	T-12	3L4' STD/ELEC	EBT	SSB1120340LH	14	105	107	-1.
413-001 NE	T-12	3L4' STD/ELEC	MAGNETEK	B34OT120	23	105	104	0.
413-001 NE	T-12	3L4' STD/ELEC	MAGNETEK	B34OT1205	28	105	104	0.
413-001 NE	T-12	3L4' STD/ELEC	MAGNETEK	B34OT2775	31	105	104	0.
413-001 NE	T-12	3L4' STD/ELEC	MAGNETEK	B34OT277	32	105	103	1.
413-001	T-12	3L4' STD/ELEC	MAGNETEK	B34OT277RH	17	105	105	
413-001	T-12	3L4' STD/ELEC	MOTOROLA	M3-RNT12-ILL277	9	105	102	2.
413-001	T-12	3L4' STD/ELEC	MOTOROLA	M3RN-T12-ILL120	9	105	103	1.
413-001	T-12	3L4' STD/ELEC	VALMONT	E340SR120G01	11	105	103	1.
413-001	T-12	3L4' STD/ELEC	VALMONT	E340SR277G01	15	105	109	-3.
413-001	T-12	3L4' STD/ELEC	VALMONT	M28-120-3	11	105	106	-0.
413-001	T-12	3L4' STD/ELEC	VALMONT	M28-277-3	11	105	106	-0.
414-001	T-12	4L4' STD/ELEC	N/A	N/A		142	142	
414-001	T-12	4L4' STD/ELEC	MAGNETEK	B440SPR120HP	6	142	138	2.
414-001	T-12	4L4' STD/ELEC	MAGNETEK	B440SPR277HP	4	142	138	2.
416-001	T-12	1L4' EE/STD	N/A	N/A		50	50	
417-001	T-12	2L4' EE/STD	N/A	N/A		80	80	
418-001	T-12	3L4' EE/STD	N/A	N/A		130	130	
419-001	T-12	4L4' EE/STD	N/A	N/A		160	160	
421-001	T-12	1L4' EE/EEMAG	N/A	N/A		42	42	

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
21-001	T-12	1L4' EE/EEMAG	MAGNETEK	412-L-SLH-TC-P	10	42	44	-4.76%
421-001	T-12	1L4' EE/EEMAG	VALMONT	8G1074UW	18	42	41	2.38%
421-001	T-12	1L4' EE/EEMAG	VALMONT	8G1074W	19	42	39	7.14%
421-001	T-12	1L4' EE/EEMAG	VALMONT	8G1078W	20	42	45	-7.14%
421-001	T-12	1L4' EE/EEMAG	VALMONT	8G1084UW	18	42	41	2.38%
421-001 NE	T-12	1L4' EE/EEMAG	VALMONT	8G1084W	39	42	39	7.14%
421-001	T-12	1L4' EE/EEMAG	VALMONT	8G1088W	19	42	45	-7.14%
422-001	T-12	2L4' EE/EEMAG	N/A	N/A		73	73	
422-001	T-12	2L4' EE/EEMAG	MAGNETEK	443-L-SLH-TC-P	10	73	77	-5.48%
422-001	T-12	2L4' EE/EEMAG	MAGNETEK	446-L-SLH-TC-P	10	73	70	4.11%
422-001 NE	T-12	2L4' EE/EEMAG	VALMONT	8G1024W	22	73	70	4.11%
422-001	T-12	2L4' EE/EEMAG	VALMONT	8G1028W	16	73	74	-1.37%
422-001 NE	T-12	2L4' EE/EEMAG	VALMONT	8G1034W	22	73	70	4.11%
422-001	T-12	2L4' EE/EEMAG	VALMONT	8G1038W	12	73	70	4.11%
423-001	T-12	3L4' EE/EEMAG	N/A	N/A		105	105	
423-001	T-12	3L4' EE/EEMAG	VALMONT	8G1324W	19	105	105	
423-001	T-12	3L4' EE/EEMAG	VALMONT	8G1334W	19	105	105	
424-001	T-12	4L4' EE/EEMAG	N/A	N/A		146	146	
426-001	T-12	1L4' EE/ELEC	N/A	N/A		32	32	
426-001	T-12	1L4' EE/ELEC	ADVANCE TR	REL-1S40-RH-TP	15	32	32	
426-001	T-12	1L4' EE/ELEC	ADVANCE TR	RIC-140-TP	8	32	32	
426-001	T-12	1L4' EE/ELEC	ADVANCE TR	VEL-1S40-RH-TP	17	32	32	
6-001	T-12	1L4' EE/ELEC	ADVANCE TR	VIC-140-TP	11	32	32	
426-001	T-12	1L4' EE/ELEC	EBT	SSB1120140LH	20	32	32	
426-001	T-12	1L4' EE/ELEC	EBT	SSB1277140LH	16	32	31	3.13%
426-001	T-12	1L4' EE/ELEC	MAGNETEK	B140T120RH	19	32	30	6.25%
426-001 NE	T-12	1L4' EE/ELEC	MAGNETEK	B140T2775	33	32	38	-18.75%
426-001	T-12	1L4' EE/ELEC	MAGNETEK	B140T277RH	19	32	30	6.25%
426-001 NE	T-12	1L4' EE/ELEC	MAGNETEK	B14OT120S	27	32	37	-15.63%
426-001	T-12	1L4' EE/ELEC	VALMONT	E140SR120G01	18	32	34	-6.25%
426-001	T-12	1L4' EE/ELEC	VALMONT	E140SR277G01	17	32	34	-6.25%
426-001 NE	T-12	1L4' EE/ELEC	VALMONT	M28-120-1	23	32	37	-15.63%
426-001 NE	T-12	1L4' EE/ELEC	VALMONT	M28-277-1	21	32	37	-15.63%
427-001	T-12	2L4' EE/ELEC	N/A	N/A		60	60	
427-001	T-12	2L4' EE/ELEC	ADVANCE TR	REL-2S40-RH-TP	16	60	59	1.67%
427-001	T-12	2L4' EE/ELEC	ADVANCE TR	RIC-2S40-TP	6	60	60	
427-001	T-12	2L4' EE/ELEC	ADVANCE TR	VEL-2S40-RH-TP	16	60	59	1.67%
427-001	T-12	2L4' EE/ELEC	ADVANCE TR	VIC-2S40-TP	12	60	60	
427-001	T-12	2L4' EE/ELEC	EBT	SSB1120240LH	13	60	61	-1.67%
427-001	T-12	2L4' EE/ELEC	EBT	SSB1277240LH	19	60	63	-5.00%
427-001	T-12	2L4' EE/ELEC	MAGNETEK	420-L-TC-P	15	60	58	3.33%
427-001	T-12	2L4' EE/ELEC	MAGNETEK	427-L-TC-P	17	60	58	3.33%
427-001 NE	T-12	2L4' EE/ELEC	MAGNETEK	B240R120	29	60	61	-1.67%
427-001	T-12	2L4' EE/ELEC	MAGNETEK	B240R120RH	18	60	63	-5.00%
427-001 NE	T-12	2L4' EE/ELEC	MAGNETEK	B240R277	25	60	61	-1.67%
427-001	T-12	2L4' EE/ELEC	MAGNETEK	B240R277HP	3	60	61	-1.67%
27-001	T-12	2L4' EE/ELEC	MAGNETEK	B240R277RH	18	60	63	-5.00%
7-001 NE	T-12	2L4' EE/ELEC	MAGNETEK	B240T120S	23	60	69	-15.00%
427-001	T-12	2L4' EE/ELEC	MAGNETEK	B240T120RH	17	60	63	-5.00%

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
427-001	T-12	2L4' EE/ELEC	MAGNETEK	B24OT277RH	17	60	63	-5.00%
427-001	T-12	2L4' EE/ELEC	MAGNETEK	B24OR120HP	6	60	61	-1.67%
427-001	T-12	2L4' EE/ELEC	MOTOROLA	M2RN-T12-ILL120	5	60	60	
427-001	T-12	2L4' EE/ELEC	MOTOROLA	M2RN-T12-ILL277	4	60	58	3.33%
427-001	T-12	2L4' EE/ELEC	VALMONT	E240SR120G01	19	60	57	5.00%
427-001	T-12	2L4' EE/ELEC	VALMONT	E240SR277G01	19	60	57	5.00%
427-001	T-12	2L4' EE/ELEC	VALMONT	M28-120	15	60	58	3.33%
427-001	T-12	2L4' EE/ELEC	VALMONT	M28-277	14	60	58	3.33%
428-001	T-12	3L4' EE/ELEC	N/A	N/A		90	90	
428-001	T-12	3L4' EE/ELEC	ADVANCE TR	REL-3S40-RH-TP	18	90	93	-3.33%
428-001	T-12	3L4' EE/ELEC	ADVANCE TR	RIC-3S40-TP	7	90	95	-5.56%
428-001	T-12	3L4' EE/ELEC	ADVANCE TR	VEL-3S40-RH-TP	18	90	93	-3.33%
428-001	T-12	3L4' EE/ELEC	ADVANCE TR	VIC-3S40-TP	14	90	93	-3.33%
428-001	T-12	3L4' EE/ELEC	EBT	SSB1120340LH	14	90	91	-1.11%
428-001	T-12	3L4' EE/ELEC	EBT	SSB1277340LH	19	90	93	-3.33%
428-001 NE	T-12	3L4' EE/ELEC	MAGNETEK	B340T120	23	90	85	5.56%
428-001 NE	T-12	3L4' EE/ELEC	MAGNETEK	B340T277S	31	90	85	5.56%
428-001 NE	T-12	3L4' EE/ELEC	MAGNETEK	B34OT277	32	90	85	5.56%
428-001	T-12	3L4' EE/ELEC	MAGNETEK	B34OT277RH	17	90	85	5.56%
428-001	T-12	3L4' EE/ELEC	MOTOROLA	M3-RNT12-ILL277	9	90	86	4.44%
428-001	T-12	3L4' EE/ELEC	MOTOROLA	M3RN-T12-ILL120	9	90	87	3.33%
428-001	T-12	3L4' EE/ELEC	VALMONT	E340SR120G01	12	90	90	
428-001	T-12	3L4' EE/ELEC	VALMONT	E340SR277G01	19	90	90	
428-001	T-12	3L4' EE/ELEC	VALMONT	M28-120-3	11	90	88	2.22%
428-001	T-12	3L4' EE/ELEC	VALMONT	M28-277-3	11	90	88	2.22%
441-001	T-8 OCTRONS	1L4' T8/EEMAG	N/A	N/A		38	38	
441-001	T-8 OCTRONS	1L4' T8/EEMAG	MAGNETEK	741-L-SLH-TC-P	9	38	39	-2.63%
441-001	T-8 OCTRONS	1L4' T8/EEMAG	MAGNETEK	748-L-SLH-TC-P	9	38	40	-5.26%
441-001	T-8 OCTRONS	1L4' T8/EEMAG	VALMONT	8G4186W18	19	38	37	2.63%
441-001	T-8 OCTRONS	1L4' T8/EEMAG	VALMONT	8G4176W18	19	38	37	2.63%
442-001	T-8 OCTRONS	2L4' T8/EEMAG	N/A	N/A		72	72	
442-001	T-8 OCTRONS	2L4' T8/EEMAG	MAGNETEK	742-L-SLH-TC-P	14	72	72	
442-001	T-8 OCTRONS	2L4' T8/EEMAG	MAGNETEK	749-L-SLH-TC-P	14	72	73	-1.39%
442-001	T-8 OCTRONS	2L4' T8/EEMAG	VALMONT	8G4126W18	19	72	71	1.39%
442-001	T-8 OCTRONS	2L4' T8/EEMAG	VALMONT	8G4136W18	19	72	71	1.39%
443-001	T-8 OCTRONS	3L4' T8/EEMAG	N/A	N/A		110	110	
444-001	T-8 OCTRONS	4L4' T8/EEMAG	N/A	N/A		144	144	
446-001	T-8 OCTRONS	1L4' T8/ELEC	N/A	N/A		31	31	
446-001	T-8 OCTRONS	1L4' T8/ELEC	ADVANCE TR	RIC-132-TP	9	31	31	
446-001	T-8 OCTRONS	1L4' T8/ELEC	ADVANCE TR	VIC-132-TP	10	31	31	
446-001	T-8 OCTRONS	1L4' T8/ELEC	EBT	SSB2120132ISLH	8	31	32	-3.23%
446-001	T-8 OCTRONS	1L4' T8/ELEC	EBT	SSB2277132ISLH	16	31	32	-3.23%
446-001 NE	T-8 OCTRONS	1L4' T8/ELEC	MAGNETEK	B132T120S	30	31	36	-16.13%
446-001	T-8 OCTRONS	1L4' T8/ELEC	MOTOROLA	M1-RN-T8-ILL120	9	31	30	3.23%
446-001	T-8 OCTRONS	1L4' T8/ELEC	MOTOROLA	M1-RN-T8-ILL277	7	31	32	-3.23%
446-001	T-8 OCTRONS	1L4' T8/ELEC	VALMONT	E132PI120G01	17	31	30	3.23%
446-001	T-8 OCTRONS	1L4' T8/ELEC	VALMONT	E132PI277G01	17	31	30	3.23%
446-001 NE	T-8 OCTRONS	1L4' T8/ELEC	VALMONT	E232PI120G01	28	31	38	-22.58%

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
16-001 NE	T-8 OCTRONS	1L4' T8/ELEC	VALMONT	E232PI277G01	27	31	38	-22.58%
447-001	T-8 OCTRONS	2L4' T8/ELEC	N/A	N/A		61	61	
447-001	T-8 OCTRONS	2L4' T8/ELEC	ADVANCE TR	REL-2P32-RH-TP	16	61	58	4.92%
447-001	T-8 OCTRONS	2L4' T8/ELEC	ADVANCE TR	RIC-2S32-TP	5	61	61	
447-001	T-8 OCTRONS	2L4' T8/ELEC	ADVANCE TR	VEL-2P32-RH-TP	16	61	58	4.92%
447-001	T-8 OCTRONS	2L4' T8/ELEC	ADVANCE TR	VIC-2S32-TP	7	61	60	1.64%
447-001	T-8 OCTRONS	2L4' T8/ELEC	EBT	SSB1120232LH	13	61	63	-3.28%
447-001	T-8 OCTRONS	2L4' T8/ELEC	EBT	SSB1277232LH	19	61	64	-4.92%
447-001	T-8 OCTRONS	2L4' T8/ELEC	EBT	SSB2120232ISLH	16	61	60	1.64%
447-001	T-8 OCTRONS	2L4' T8/ELEC	EBT	SSB2120232ISMPX	16	61	58	4.92%
447-001	T-8 OCTRONS	2L4' T8/ELEC	EBT	SSB2277232ISMPX	16	61	58	4.92%
447-001	T-8 OCTRONS	2L4' T8/ELEC	EBT	SSB2277232ISLH	16	61	60	1.64%
447-001	T-8 OCTRONS	2L4' T8/ELEC	MAGNETEK	B232I120RH	14	61	62	-1.64%
447-001	T-8 OCTRONS	2L4' T8/ELEC	MAGNETEK	B232I277	18	61	63	-3.28%
447-001	T-8 OCTRONS	2L4' T8/ELEC	MAGNETEK	B232I277RH	14	61	62	-1.64%
447-001	T-8 OCTRONS	2L4' T8/ELEC	MAGNETEK	B232T120	19	61	63	-3.28%
447-001 NE	T-8 OCTRONS	2L4' T8/ELEC	MAGNETEK	B232T120S	27	61	65	-6.56%
447-001 NE	T-8 OCTRONS	2L4' T8/ELEC	MAGNETEK	B232T277S	29	61	63	-3.28%
447-001	T-8 OCTRONS	2L4' T8/ELEC	MOTOROLA	M2-RH-T8-ILL122	9	61	65	-6.56%
447-001	T-8 OCTRONS	2L4' T8/ELEC	MOTOROLA	M2-RH-T8-ILL277	5	61	64	-4.92%
447-001	T-8 OCTRONS	2L4' T8/ELEC	MOTOROLA	M2-RN-T8-ILL120	4	61	60	1.64%
447-001	T-8 OCTRONS	2L4' T8/ELEC	MOTOROLA	M2-RN-T8-ILL277	5	61	59	3.28%
447-001	T-8 OCTRONS	2L4' T8/ELEC	OSRAM CORP	QT-140	16	61	62	-1.64%
447-001	T-8 OCTRONS	2L4' T8/ELEC	OSRAM CORP	QT-160	17	61	62	-1.64%
7-001	T-8 OCTRONS	2L4' T8/ELEC	OSRAM CORP	QT-120	13	61	62	-1.64%
7-001	T-8 OCTRONS	2L4' T8/ELEC	ROBERTSON	RER2LT8-120	7	61	62	-1.64%
447-001	T-8 OCTRONS	2L4' T8/ELEC	ROBERTSON	RER2LT8-277	7	61	62	-1.64%
447-001 NE	T-8 OCTRONS	2L4' T8/ELEC	SYLVANIA	SS120-2T8-32	25	61	55	9.84%
447-001 NE	T-8 OCTRONS	2L4' T8/ELEC	SYLVANIA	SS277-2T8-32	25	61	55	9.84%
447-001	T-8 OCTRONS	2L4' T8/ELEC	VALMONT	E232PI120GO1	16	61	59	3.28%
447-001	T-8 OCTRONS	2L4' T8/ELEC	VALMONT	E232PI2777G01	17	61	59	3.28%
447-001	T-8 OCTRONS	2L4' T8/ELEC	VALMONT	E232SR120G01	17	61	61	
447-001	T-8 OCTRONS	2L4' T8/ELEC	VALMONT	E232SR277G01	16	61	62	-1.64%
447-002	T-8 OCTRONS LO	2L4' T8/ELEC/LO	N/A	N/A		55	55	
447-002	T-8 OCTRONS LO	2L4' T8/ELEC/LO	MAGNETEK	B232I277L	18	55	54	1.82%
447-002	T-8 OCTRONS LO	2L4' T8/ELEC/LO	MAGNETEK	B232T12OL	17	55	55	
447-003	T-8 OCTRONS HI	2L4' T8/ELEC/HI	N/A	N/A		82	82	
447-003	T-8 OCTRONS HI	2L4' T8/ELEC/HI	MOTOROLA	M2-RH-T8-ILL120	3	82	86	-4.88%
447-003	T-8 OCTRONS HI	2L4' T8/ELEC/HI	OSRAM CORP	QT-060	13	82	78	4.88%
448-001	T-8 OCTRONS	3L4' T8/ELEC	N/A	N/A		89	89	
448-001	T-8 OCTRONS	3L4' T8/ELEC	ADVANCE TR	REL-3P32-RH-TP	15	89	87	2.25%
448-001	T-8 OCTRONS	3L4' T8/ELEC	ADVANCE TR	RIC-3S32-TP	6	89	94	-5.62%
448-001	T-8 OCTRONS	3L4' T8/ELEC	ADVANCE TR	VIC-3S32-TP	10	89	93	-4.49%
448-001	T-8 OCTRONS	3L4' T8/ELEC	EBT	SSB2120332ISLH	17	89	88	1.12%
448-001	T-8 OCTRONS	3L4' T8/ELEC	EBT	SSB2277332ISLH	19	89	91	-2.25%
448-001	T-8 OCTRONS	3L4' T8/ELEC	MAGNETEK	B332I120HP	8	89	90	-1.12%
448-001	T-8 OCTRONS	3L4' T8/ELEC	MAGNETEK	B332I120RH	18	89	86	3.37%
-001 NE	T-8 OCTRONS	3L4' T8/ELEC	MAGNETEK	B332I277	32	89	89	
48-001	T-8 OCTRONS	3L4' T8/ELEC	MAGNETEK	B332I277HP	6	89	89	
448-001	T-8 OCTRONS	3L4' T8/ELEC	MAGNETEK	B332I277RH	18	89	90	-1.12%

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
448-001	T-8 OCTRONS	3L4' T8/ELEC	MOTOROLA	M3-RN-T8-ILL120	5	89	87	2.25%
448-001	T-8 OCTRONS	3L4' T8/ELEC	MOTOROLA	M3-RN-T8-ILL277	5	89	90	-1.12%
448-001	T-8 OCTRONS	3L4' T8/ELEC	OSRAM CORP	QT-020	16	89	88	1.12%
448-001	T-8 OCTRONS	3L4' T8/ELEC	OSRAM CORP	QT-040	18	89	88	1.12%
448-001	T-8 OCTRONS	3L4' T8/ELEC	VALMONT	E332PI120G01	17	89	86	3.37%
448-001	T-8 OCTRONS	3L4' T8/ELEC	VALMONT	E332PI120G01	10	89	86	3.37%
448-001	T-8 OCTRONS	3L4' T8/ELEC	VALMONT	E332PI277G01	14	89	85	4.49%
448-001	T-8 OCTRONS	3L4' T8/ELEC	VALMONT	E432PI277G01	20	89	86	3.37%
448-001	T-8 OCTRONS	3L4' T8/ELEC	VALMONT	E432PI120G01	20	89	86	3.37%
448-001	T-8 OCTRONS	3L4' T8/ELEC	VALMONT	E332PI277G01	17	89	86	3.37%
448-001	T-8 OCTRONS	3L4' T8/ELEC	VALMONT	E332PI120G01	17	89	86	3.37%
448-002	T-8 OCTRONS LO	3L4' T8/ELEC LO	N/A	N/A		79	79	
448-002	T-8 OCTRONS LO	3L4' T8/ELEC LO	ADVANCE TR	VEL-3P32-RH-TP	16	79	82	-3.80%
448-002	T-8 OCTRONS LO	3L4' T8/ELEC LO	MAGNETEK	B332I120L	17	79	78	1.27%
448-002	T-8 OCTRONS LO	3L4' T8/ELEC LO	MAGNETEK	B332I277L	17	79	80	-1.27%
448-002 NE	T-8 OCTRONS LO	3L4' T8/ELEC LO	SYLVANIA	SS120-3T8-32	25	79	78	1.27%
448-002 NE	T-8 OCTRONS LO	3L4' T8/ELEC LO	SYLVANIA	SS277-3T8-32	25	79	78	1.27%
448-003	T-8 OCTRONS HI	3L4' T8/ELEC HI	N/A	N/A		97	97	
448-003	T-8 OCTRONS HI	3L4' T8/ELEC HI	EBT	SSB1120332LH	14	97	98	-1.03%
448-003	T-8 OCTRONS HI	3L4' T8/ELEC HI	EBT	SSB1277332LH	19	97	97	
448-003	T-8 OCTRONS HI	3L4' T8/ELEC HI	MOTOROLA	M3-RN-T8-2LI120	4	97	95	2.06%
449-001	T-8 OCTRONS	4L4' T8/ELEC	N/A	N/A		110	110	
449-001	T-8 OCTRONS	4L4' T8/ELEC	ADVANCE TR	REL-4P32-RH-TP	14	110	112	-1.82%
449-001	T-8 OCTRONS	4L4' T8/ELEC	ADVANCE TR	VEL-4P32-RH-TP	14	110	110	
449-001	T-8 OCTRONS	4L4' T8/ELEC	EBT	SSB2120432ISLH	13	110	115	-4.55%
449-001	T-8 OCTRONS	4L4' T8/ELEC	EBT	SSB2277432ISLH	15	110	116	-5.45%
449-001 NE	T-8 OCTRONS	4L4' T8/ELEC	MAGNETEK	B432I120	23	110	115	-4.55%
449-001	T-8 OCTRONS	4L4' T8/ELEC	MAGNETEK	B432I120HP	4	110	115	-4.55%
449-001	T-8 OCTRONS	4L4' T8/ELEC	MAGNETEK	B432I120RH	17	110	114	-3.64%
449-001	T-8 OCTRONS	4L4' T8/ELEC	MAGNETEK	B432I277HP	4	110	116	-5.45%
449-001	T-8 OCTRONS	4L4' T8/ELEC	MAGNETEK	B432I277RH	19	110	116	-5.45%
449-001 NE	T-8 OCTRONS	4L4' T8/ELEC	MAGNETEK	B432T277	31	110	110	
449-001	T-8 OCTRONS	4L4' T8/ELEC	MOTOROLA	M4-RN-T8-ILL120	3	110	115	-4.55%
449-001	T-8 OCTRONS	4L4' T8/ELEC	MOTOROLA	M4-RN-T8-ILL277	7	110	115	-4.55%
449-001	T-8 OCTRONS	4L4' T8/ELEC	OSRAM CORP	QT-100	10	110	110	
449-001	T-8 OCTRONS	4L4' T8/ELEC	OSRAM CORP	QT-080	14	110	110	
449-001 NE	T-8 OCTRONS	4L4' T8/ELEC	SYLVANIA	SS120-4T8-32	25	110	105	4.55%
449-001 NE	T-8 OCTRONS	4L4' T8/ELEC	SYLVANIA	SS277-4T8-32	25	110	105	4.55%
449-002	T-8 OCTRONS LO	4L4' T8/ELEC/LO	N/A	N/A		99	99	
449-002	T-8 OCTRONS LO	4L4' T8/ELEC/LO	MAGNETEK	B432I12OL	19	99	98	1.01%
449-002	T-8 OCTRONS LO	4L4' T8/ELEC/LO	MAGNETEK	B432I277L	19	99	97	2.02%
449-002	T-8 OCTRONS LO	4L4' T8/ELEC/LO	VALMONT	E432PI120G01	13	99	101	-2.02%
449-002	T-8 OCTRONS LO	4L4' T8/ELEC/LO	VALMONT	E432PI277G01	15	99	101	-2.02%
461-001	T-12 HO	1L4' F48T12/STD	N/A	N/A		60	60	
462-001	T-12 HO	2L4' F48T12/STD	N/A	N/A		102	102	
463-001	T-12 HO	3L4' F48T12/STD	N/A	N/A		162	162	
464-001	T-12 HO	4L4' F48T12/STD	N/A	N/A		204	204	
466-001	T-12 HO	1L4' EEF48T12/STD	N/A	N/A		50	50	

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
67-001	T-12 HO	2L4' EEF48T12/STD	N/A	N/A		82	82	
468-001	T-12 HO	3L4' EEF48T12/STD	N/A	N/A		132	132	
469-001	T-12 HO	4L4' EEF48T12STD	N/A	N/A		164	164	
471-001	T-12 HO	1L4' HOSTD/STD	N/A	N/A		85	85	
472-001	T-12 HO	2L4' HOSTD/STD	N/A	N/A		145	145	
473-001	T-12 HO	3L4' HOSTD/STD	N/A	N/A		230	230	
474-001	T-12 HO	4L4' HOSTD/STD	N/A	N/A		290	290	
476-001	T-12 HO	1L4' EE HO/STD	N/A	N/A		80	80	
477-001	T-12 HO	2L4' EE HO/STD	N/A	N/A		135	135	
478-001	T-12 HO	3L4' EE HO/STD	N/A	N/A		215	215	
479-001	T-12 HO	4L4' EE HO/STD	N/A	N/A		270	270	
481-001	T-12 VHO	1L4' VHOSTD/STD	N/A	N/A		138	138	
482-001	T-12 VHO	2L4' VHOSTD/STD	N/A	N/A		240	240	
483-001	T-12 VHO	3L4' VHOSTD/STD	N/A	N/A		378	378	
484-001	T-12 VHO	4L4' VHOSTD/STD	N/A	N/A		480	480	
486-001	T-12 VHO	1L4' EEVHO/STD	N/A	N/A		123	123	
487-001	T-12 VHO	2L4' EEVHO/STD	N/A	N/A		210	210	
488-001	T-12 VHO	3L4' EEVHO/STD	N/A	N/A		333	333	
489-001	T-12 VHO	4L4' EEVHO/STD	N/A	N/A		420	420	
501-001	T-12	(1) F20T12/HPFMAG	N/A	N/A		32	32	
2-001	T-12	(2) F20T12/HPFMAG	N/A	N/A		56	56	
03-001	T-12	(3) F20T12/HPFMAG	N/A	N/A		78	78	
504-001	T-12	(4) F20T12/HPFMAG	N/A	N/A		112	112	
506-001	T-8 OCTRONS	(1) FO17T8/EEMAG	N/A	N/A		24	24	
506-001	T-8 OCTRONS	(1) FO17T8/EEMAG	MAGNETEK	703-L-TC-P		24	24	
507-001	T-8 OCTRONS	(2) F017T8/EEMAG	N/A	N/A		43	43	
507-001	T-8 OCTRONS	(2) F017T8/EEMAG	MAGNETEK	701-L-TC-P		43	43	
508-001	T-8 OCTRONS	(3) F017T8/EEMAG	N/A	N/A		67	67	
509-001	T-8 OCTRONS	(4) F017T8/EEMAG	N/A	N/A		86	86	
511-001	T-8 OCTRONS	(1) FO17T8/ELEC	N/A	N/A		18	18	
512-001	T-8 OCTRONS	(2) F017T8/ELEC	N/A	N/A		34	34	
512-001	T-8 OCTRONS	(2) F017T8/ELEC	MAGNETEK	B232I120		34	34	
513-001	T-8 OCTRONS	(3) F017T8/ELEC	N/A	N/A		50	50	
513-001	T-8 OCTRONS	(3) F017T8/ELEC	ADVANCE TR	B332I120		50	50	
514-001	T-8 OCTRONS	(4) F017T8/ELEC	N/A	N/A		62	62	
514-001	T-8 OCTRONS	(4) F017T8/ELEC	ADVANCE TR	B432I120		62	62	
521-001	T-12	(1) F30T12STD/STD	N/A	N/A		46	46	
522-001	T-12	(2) F30T12STD/STD	N/A	N/A		80	80	
523-001	T-12	(3) F30T12STD/STD	N/A	N/A		126	126	
1-001	T-12	(4) F30T12STD/STD	N/A	N/A		160	160	
526-001	T-12	(1) F30T12EE/STD	N/A	N/A		42	42	

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
527-001	T-12	(2) F30T12EE/STD	N/A	N/A		73	73	
528-001	T-12	(3) F30T12EE/STD	N/A	N/A		115	115	
529-001	T-12	(4) F30T12EE/STD	N/A	N/A		146	146	
531-001	T-8 OCTRONS	(1) F025T8/EEMAG	N/A	N/A		30	30	
531-001	T-8 OCTRONS	(1) F025T8/EEMAG	MAGNETEK	727-L-TC-P		30	30	
532-001	T-8 OCTRONS	(2) F025T8/EEMAG	N/A	N/A		58	58	
532-001	T-8 OCTRONS	(2) F025T8/EEMAG	MAGNETEK	731-L-TC-P		58	58	
533-001	T-8 OCTRONS	(3) F025T8/EEMAG	N/A	N/A		88	88	
534-001	T-8 OCTRONS	(4) F025T8/EEMAG	N/A	N/A		116	116	
536-001	T-8 OCTRONS	(1) FO25T8/ELEC	N/A	N/A		30	30	
536-001	T-8 OCTRONS	(1) FO25T8/ELEC	MAGNETEK	B232I120		30	30	
537-001	T-8 OCTRONS	(2) F025T8/ELEC	N/A	N/A		48	48	
537-001	T-8 OCTRONS	(2) F025T8/ELEC	MAGNETEK	B232I120		48	48	
538-001	T-8 OCTRONS	(3) F025T8/ELEC	N/A	N/A		68	68	
538-001	T-8 OCTRONS	(3) F025T8/ELEC	ADVANCE TR	B332I120		68	68	
539-001	T-8 OCTRONS	(4) F025T8/ELEC	N/A	N/A		90	90	
539-001	T-8 OCTRONS	(4) F025T8/ELEC	ADVANCE TR	B432I120		90	90	
541-001	T-12	1L4' STD/HYBRID	N/A	N/A		43	43	
541-001	T-12	1L4' STD/HYBRID	MAGNETEK	410-L-TC-P	14	43	45	
541-001	T-12	1L4' STD/HYBRID	MAGNETEK	417-L-TC-P	14	43	40	
541-001	T-12	1L4' STD/HYBRID	VALMONT	M28-120-1	20	43	45	
542-001	T-12	2L4' STD/HYBRID	N/A	N/A		72	72	
542-001	T-12	2L4' STD/HYBRID	MAGNETEK	420-L-TC-P	18	72	71	
542-001	T-12	2L4' STD/HYBRID	MAGNETEK	427-L-TC-P	18	72	72	
546-001	T-12	1L4' EE/HYBRID	N/A	N/A		37	37	
546-001	T-12	1L4' EE/HYBRID	MAGNETEK	410-L-TC-P	14	37	37	
546-001	T-12	1L4' EE/HYBRID	MAGNETEK	417-L-TC-P	14	37	37	
547-001	T-12	2L4' EE/HYBRID	N/A	N/A		68	68	
547-001	T-12	2L4' EE/HYBRID	MAGNETEK	530-L-TC-P	15	68	68	
547-001	T-12	2L4' EE/HYBRID	MAGNETEK	537-L-TC-P	13	68	68	
551-001	T-8 OCTRONS- 2 LEVEL	1L4' T8/ELEC/2STEP	N/A	N/A		36	36	
551-001 NE	T-8 OCTRONS- 2 LEVEL	1L4' T8/ELEC/2STEP	MAGNETEK	B132T277S	30	36	36	
552-001	T-8 OCTRONS- 2 LEVEL	2L4' T8/ELEC/2STEP	N/A	N/A		65	65	
553-001	T-8 OCTRONS- 2 LEVEL	3L4' T8/ELEC/2STEP	N/A	N/A		95	95	
562-001	F40	2L4' F40STD/ELEC-BX	N/A	N/A		66	66	
562-001	F40	2L4' F40STD/ELEC-BX	MOTOROLA	M2RNT5/40ILL120	5	66	66	
562-001	F40	2L4' F40STD/ELEC-BX	MOTOROLA	M2RNT5/40ILL277	5	66	66	
572-001	T-12	2L4' STD/HYB FL	N/A	N/A		82	82	
572-001	T-12	2L4' STD/HYB FL	MAGNETEK	530-L-TC-P	15	82	81	

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
72-001	T-12	2L4' STD/HYB FL	MAGNETEK	537-L-TC-P	13	82	82	
601-001	T-12	1L8' STD/STD	N/A	N/A		100	100	
602-001	T-12	2L8' STD/STD	N/A	N/A		173	173	
603-001	T-12	3L8' STD/STD	N/A	N/A		273	273	
604-001	T-12	4L8' STD/STD	N/A	N/A		346	346	
606-001	T-12	1L8' STD/EEMAG	N/A	N/A		78	78	
607-001	T-12	2L8' STD/EEMAG	N/A	N/A		158	158	
607-001	T-12	2L8' STD/EEMAG	MAGNETEK	827-SLH-TCP		158	158	
608-001	T-12	3L8' STD/EEMAG	N/A	N/A		236	236	
609-001	T-12	4L8' STD/EEMAG	N/A	N/A		316	316	
611-001	T-12	1L8' STD/ELEC	N/A	N/A		71	71	
612-001	T-12	2L8' STD/ELEC	N/A	N/A		135	135	
612-001	T-12	2L8' STD/ELEC	ADVANCE TR	REF-2P75-SRH-TP	10	135	140	-3.70%
612-001	T-12	2L8' STD/ELEC	ADVANCE TR	VEL-2P75-S-RHTP	14	135	135	
612-001	T-12	2L8' STD/ELEC	EBT	SSB2120296ISLH	14	135	132	2.22%
612-001	T-12	2L8' STD/ELEC	EBT	SSB2277296ISLH	15	135	132	2.22%
612-001	T-12	2L8' STD/ELEC	MAGNETEK	B275I277RH	17	135	141	-4.44%
612-001	T-12	2L8' STD/ELEC	MAGNETEK	B275I120RH-2	12	135	139	-2.96%
612-001 NE	T-12	2L8' STD/ELEC	MAGNETEK	B275I277	29	135	141	-4.44%
612-001	T-12	2L8' STD/ELEC	MOTOROLA	M2IN-T12-SL120	9	135	131	2.96%
612-001	T-12	2L8' STD/ELEC	MOTOROLA	M2IN-T12-SL277	9	135	131	2.96%
12-001	T-12	2L8' STD/ELEC	OSRAM CORP	QT-190	15	135	140	-3.70%
.2-001	T-12	2L8' STD/ELEC	OSRAM CORP	QT-180	17	135	135	
612-001	T-12	2L8' STD/ELEC	VALMONT	E296PI120G01	15	135	136	-0.74%
612-001	T-12	2L8' STD/ELEC	VALMONT	E296PI277G01	19	135	136	-0.74%
614-001	T-12	4L8' STD/ELEC	N/A	N/A		270	270	
616-001	T-12	1L8' EE/STD	N/A	N/A		83	83	
617-001	T-12	2L8' EE/STD	N/A	N/A		138	138	
618-001	T-12	3L8' EE/STD	N/A	N/A		221	221	
619-001	T-12	4L8' EE/STD	N/A	N/A		276	276	
621-001	T-12	1L8' EE/EEMAG	N/A	N/A		72	72	
621-001	T-12	1L8' EE/EEMAG	VALMONT	E296PI120G01		72	71	1.39%
621-001	T-12	1L8' EE/EEMAG	VALMONT	E296PI277G01		72	71	1.39%
622-001	T-12	2L8' EE/EEMAG	N/A	N/A		123	123	
622-001	T-12	2L8' EE/EEMAG	MAGNETEK	806-SLH-TC-P		123	122	0.81%
622-001	T-12	2L8' EE/EEMAG	VALMONT	8G1004W	17	123	123	
624-001	T-12	4L8' EE/EEMAG	N/A	N/A		246	246	
625-001	T-12	1L8' EE/ELEC	N/A	N/A		65	65	
626-001	T-12	2L8' EE/ELEC	N/A	N/A		108	108	
626-001	T-12	2L8' EE/ELEC	ADVANCE TR	REL-2P75-SRH-TP	10	108	110	-1.85%
626-001	T-12	2L8' EE/ELEC	ADVANCE TR	VEL-2P75-S-RHTP	14	108	110	-1.85%
6-001	T-12	2L8' EE/ELEC	EBT	SSB2120296ISLH	14	108	107	0.93%
26-001	T-12	2L8' EE/ELEC	EBT	SSB2277296ISLH	15	108	107	0.93%
626-001	T-12	2L8' EE/ELEC	MAGNETEK	B275T277RH	17	108	112	-3.70%

LUMINAIRE WATTAGE TABLE

Code		Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
626-001	T-12		2L8' EE/ELEC	MAGNETEK	B275I120RH-2	12	108	112	-3.70%
626-001 NE	T-12		2L8' EE/ELEC	MAGNETEK	B275I277	29	108	112	-3.70%
626-001	T-12		2L8' EE/ELEC	MOTOROLA	M2IN-T12-SL120	9	108	104	3.70%
626-001	T-12		2L8' EE/ELEC	MOTOROLA	M2IN-T12-SL277	9	108	104	3.70%
626-001	T-12		2L8' EE/ELEC	OSRAM CORP	QT-190	15	108	108	
626-001	T-12		2L8' EE/ELEC	VALMONT	E296PI120G01	19	108	108	
626-001	T-12		2L8' EE/ELEC	VALMONT	E296PI277G01	19	108	108	
626-001	T-12		2L8' EE/ELEC	VALMONT	F296PI277G01	19	108	108	
628-001	T-12		4L8' EE/ELEC	N/A	N/A		216	216	
631-001	T-12 HO		1L8' HO STD/STD	N/A	N/A		135	135	
632-001	T-12 HO		2L8' HO STD/STD	N/A	N/A		257	257	
633-001	T-12 HO		3L8' HO STD/STD	N/A	N/A		392	392	
634-001	T-12 HO		4L8' HO STD/STD	N/A	N/A		514	514	
637-001	T-12 HO		2L8' HO STD/EEMAG	N/A	N/A		237	237	
637-001	T-12 HO		2L8' HO STD/EEMAG	MAGNETEK	480-SLH-TC-P		237	237	
639-001	T-12 HO		4L8' HO STD/EEMAG	N/A	N/A		474	474	
642-001	T-12 HO		2L8' HO/STD/ELEC	N/A	N/A		200	200	
642-001	T-12 HO		2L8' HO/STD/ELEC	ADVANCE TR	VEL-2S110-RH-TP	17	200	193	3.50%
642-001	T-12 HO		2L8' HO/STD/ELEC	EBT	SSB1120296HOLH	16	200	210	-5.00%
642-001	T-12 HO		2L8' HO/STD/ELEC	EBT	SSB1277296HOLH	19	200	208	-4.00%
642-001	T-12 HO		2L8' HO/STD/ELEC	MAGNETEK	B2110SR120L	14	200	190	5.00%
642-001 NE	T-12 HO		2L8' HO/STD/ELEC	MAGNETEK	B2110SR277	29	200	190	5.00%
642-001	T-12 HO		2L8' HO/STD/ELEC	MAGNETEK	B2110SR277L	16	200	190	5.00%
642-001	T-12 HO		2L8' HO/STD/ELEC	MAGNETEK	B2110SR120	16	200	190	5.00%
642-001	T-12 HO		2L8' HO/STD/ELEC	OSRAM CORP	QT-200	16	200	210	-5.00%
642-001	T-12 HO		2L8' HO/STD/ELEC	OSRAM CORP	QT-210	19	200	210	-5.00%
646-001	T-12 HO		1L8' EE HO/STD	N/A	N/A		125	125	
647-001	T-12 HO		2L8' EE HO/STD	N/A	N/A		227	227	
648-001	T-12 HO		3L8' EE HO/STD	N/A	N/A		352	352	
649-001	T-12 HO		4L8' EE HO/STD	N/A	N/A		454	454	
651-001	T-12 HO		1L8' EE HO/EEMAG	N/A	N/A		105	105	
652-001	T-12 HO		2L8' EE/HO/EEMAG	N/A	N/A		197	197	
652-001	T-12 HO		2L8' EE/HO/EEMAG	MAGNETEK	480-SLH-TC-P		197	197	
652-001	T-12 HO		2L8' EE/HO/EEMAG	MAGNETEK	487-SLH-TC-P		197	197	
652-001 NE	T-12 HO		2L8' EE/HO/EEMAG	VALMONT	E296PI120601	32	197	207	-5.08%
652-001 NE	T-12 HO		2L8' EE/HO/EEMAG	VALMONT	E296PI277601	32	197	207	-5.08%
653-001	T-12 HO		3L8' EE/HO/EEMAG	N/A	N/A		292	292	
654-001	T-12 HO		4L8' EE HO/EEMAG	N/A	N/A		394	394	
655-001	T-12 HO		1L8' EE/HO/ELEC	N/A	N/A		95	95	
656-001	T-12 HO		2L8' EE/HO/ELEC	N/A	N/A		180	180	
656-001	T-12 HO		2L8' EE/HO/ELEC	MAGNETEK	B2110SR120L	14	180	184	-2.22%
656-001	T-12 HO		2L8' EE/HO/ELEC	MAGNETEK	B2110SR277L	16	180	184	-2.22%
656-001	T-12 HO		2L8' EE/HO/ELEC	MAGNETEK	REL-2S110-RH-TP	9	180	172	4.44%
656-001	T-12 HO		2L8' EE/HO/ELEC	OSRAM CORP	QT-200	16	180	175	2.78%
656-001	T-12 HO		2L8' EE/HO/ELEC	OSRAM CORP	QT-210	19	180	175	2.78%

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
656-002	T-12 HO/LO	2L8' EE/HO/ELEC/LO	N/A	N/A		165	165	
656-002	T-12 HO/LO	2L8' EE/HO/ELEC/LO	MAGNETEK	VEL-2S110-RH-T	17	165	167	-1.21%
656-002	T-12 HO/LO	2L8' EE/HO/ELEC/LO	VALMONT	E296SH120G11	19	165	164	0.61%
656-002	T-12 HO/LO	2L8' EE/HO/ELEC/LO	VALMONT	E296SH277G11	19	165	164	0.61%
656-003	T-12 HO/HI	2L8' EE/HO/ELEC/HI	N/A	N/A		203	203	
656-003	T-12 HO/HI	2L8' EE/HO/ELEC/HI	ADVANCE TR	REL-2S110-RH-TP	9	203	197	2.96%
656-003	T-12 HO/HI	2L8' EE/HO/ELEC/HI	ADVANCE TR	VEL-2S110-RH-T	17	203	193	4.93%
656-003	T-12 HO/HI	2L8' EE/HO/ELEC/HI	EBT	SSB1120296HOLH	16	203	210	-3.45%
656-003	T-12 HO/HI	2L8' EE/HO/ELEC/HI	EBT	SSB1277296HOLH	19	203	208	-2.46%
656-003 NE	T-12 HO/HI	2L8' EE/HO/ELEC/HI	MAGNETEK	B2110SR277	29	203	209	-2.96%
656-003	T-12 HO/HI	2L8' EE/HO/ELEC/HI	VALMONT	15G3419W18	19	203	210	-3.45%
656-003 NE	T-12 HO/HI	2L8' EE/HO/ELEC/HI	MAGNETEK	B2110SR120	25	203	209	-2.96%
658-001	T-12 HO	4L8' EE HO/ELEC	N/A	N/A		360	360	
661-001	T-12 VHO	1L8' VHO STD/STD	N/A	N/A		230	230	
662-001	T-12 VHO	2L8' VHO STD/STD	N/A	N/A		450	450	
663-001	T-12 VHO	3L8' VHO STD/STD	N/A	N/A		680	680	
664-001	T-12 VHO	4L8' VHO STD/STD	N/A	N/A		900	900	
666-001	T-12 VHO	1L8' EE VHO/STD	N/A	N/A		200	200	
667-001	T-12 VHO	2L8' EE VHO/STD	N/A	N/A		390	390	
668-001	T-12 VHO	3L8' EE VHO/STD	N/A	N/A		590	590	
669-001	T-12 VHO	4L8' EE VHO/STD	N/A	N/A		780	780	
701-001	MERCURY VAPOR	40W MV/BALLAST	N/A	N/A		50	50	
703-001	MERCURY VAPOR	30W MV/BALLAST	N/A	N/A		75	75	
705-001	MERCURY VAPOR	75W MV/BALLAST	N/A	N/A		95	95	
707-001	MERCURY VAPOR	100W MV/BALLAST	N/A	N/A		120	120	
707-001	MERCURY VAPOR	100W MV/BALLAST	HOLOPHANE	C-1513-D/480V		120	120	
707-001	MERCURY VAPOR	100W MV/BALLAST	HOLOPHANE	EC-1509-D/120V		120	120	
707-001	MERCURY VAPOR	100W MV/BALLAST	HOLOPHANE	EC-1512-D/277V		120	120	
707-001	MERCURY VAPOR	100W MV/BALLAST	HOLOPHANE	EC-2668-D/MTB		120	120	
707-001	MERCURY VAPOR	100W MV/BALLAST	VALMONT	15G3419W18		120	120	
709-001	MERCURY VAPOR	175W MV/BALLAST	N/A	N/A		205	205	
709-001	MERCURY VAPOR	175W MV/BALLAST	HOLOPHANE	EC-1514-D/120V		205	200	2.44%
709-001	MERCURY VAPOR	175W MV/BALLAST	HOLOPHANE	EC-1517-D/277V		205	202	1.46%
709-001	MERCURY VAPOR	175W MV/BALLAST	HOLOPHANE	EC-1518-D/480V		205	202	1.46%
709-001	MERCURY VAPOR	175W MV/BALLAST	HOLOPHANE	EC-2733-D/MTB		205	202	1.46%
709-001	MERCURY VAPOR	175W MV/BALLAST	VALMONT	15G4419W18		205	210	-2.44%
711-001	MERCURY VAPOR	250W MV/BALLAST	N/A	N/A		290	290	
711-001	MERCURY VAPOR	250W MV/BALLAST	HOLOPHANE	EC-1524-D/120V		290	290	
711-001	MERCURY VAPOR	250W MV/BALLAST	HOLOPHANE	EC-1525-D/208V		290	290	
711-001	MERCURY VAPOR	250W MV/BALLAST	HOLOPHANE	EC-1526-D/240V		290	290	
711-001	MERCURY VAPOR	250W MV/BALLAST	HOLOPHANE	EC-1528-D/480V		290	290	
711-001	MERCURY VAPOR	250W MV/BALLAST	HOLOPHANE	EC-1527-D/277V		290	290	
711-001	MERCURY VAPOR	250W MV/BALLAST	VALMONT	15G5419W18		290	300	-3.45%
713-001	MERCURY VAPOR	400W MV/BALLAST	N/A	N/A		450	450	
713-001	MERCURY VAPOR	400W MV/BALLAST	HOLOPHANE	EC-1031-A/480V		450	460	-2.22%

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
713-001	MERCURY VAPOR	400W MV/BALLAST	HOLOPHANE	EC-1032-A/120V		450	445	1.11%
713-001	MERCURY VAPOR	400W MV/BALLAST	HOLOPHANE	EC-1033-A/208V		450	445	1.11%
713-001	MERCURY VAPOR	400W MV/BALLAST	HOLOPHANE	EC-1034-A/240V		450	445	1.11%
713-001	MERCURY VAPOR	400W MV/BALLAST	HOLOPHANE	EC-1035-A/277V		450	445	1.11%
713-001	MERCURY VAPOR	400W MV/BALLAST	VALMONT	15G6449W18		450	450	
715-001	MERCURY VAPOR	(2) 400W MV/BALLAST	N/A	N/A		880	880	
717-001	MERCURY VAPOR	700W MV/BALLAST	N/A	N/A		775	775	
719-001	MERCURY VAPOR	1000W MV/BALLAST	N/A	N/A		1075	1075	
719-001	MERCURY VAPOR	1000W MV/BALLAST	HOLOPHANE	EC-1067-A/120V		1075	1075	
719-001	MERCURY VAPOR	1000W MV/BALLAST	HOLOPHANE	EC-1068-A/208V		1075	1075	
719-001	MERCURY VAPOR	1000W MV/BALLAST	HOLOPHANE	EC-1069-A/240V		1075	1075	
719-001	MERCURY VAPOR	1000W MV/BALLAST	HOLOPHANE	EC-1070-A/277V		1075	1075	
719-001	MERCURY VAPOR	1000W MV/BALLAST	HOLOPHANE	EC-1071-A/480V		1075	1075	
719-001	MERCURY VAPOR	1000W MV/BALLAST	HOLOPHANE	EC1069-A/240V		1075	1075	
719-001	MERCURY VAPOR	1000W MV/BALLAST	VALMONT	15G7429W18		1075	1060	1.40%
721-001	METAL HALIDE	32W MH/BALLAST	N/A	N/A		40	40	
723-001	METAL HALIDE	70W MH/BALLAST	N/A	N/A		95	95	
723-001	METAL HALIDE	70W MH/BALLAST	HOLOPHANE	BL-76 MTB		95	95	
723-001	METAL HALIDE	70W MH/BALLAST	VALMONT	16G8220		95	93	2.11%
725-001	METAL HALIDE	100W MH/BALLAST	N/A	N/A		120	120	
725-001	METAL HALIDE	100W MH/BALLAST	VALMONT	15G3419W18		120	120	
727-001	METAL HALIDE	150W MH/BALLAST	N/A	N/A		195	195	
729-001	METAL HALIDE	175W MH/BALLAST	N/A	N/A		215	215	
729-001	METAL HALIDE	175W MH/BALLAST	HOLOPHANE	EC-4035/120V		215	211	1.86%
729-001	METAL HALIDE	175W MH/BALLAST	HOLOPHANE	EC-4038/277V		215	212	1.40%
729-001	METAL HALIDE	175W MH/BALLAST	HOLOPHANE	EC-4039/480V		215	220	-2.33%
729-001	METAL HALIDE	175W MH/BALLAST	HOLOPHANE	EC-4040/MTB		215	215	
729-001	METAL HALIDE	175W MH/BALLAST	VALMONT	16G1299W18		215	210	2.33%
731-001	METAL HALIDE	250W MH/BALLAST	N/A	N/A		286	286	
731-001	METAL HALIDE	250W MH/BALLAST	HOLOPHANE	EC-4112-L		286	280	2.10%
731-001	METAL HALIDE	250W MH/BALLAST	HOLOPHANE	EC-4115-L/277V		286	283	1.05%
731-001	METAL HALIDE	250W MH/BALLAST	HOLOPHANE	EC-4116-L/480V		286	285	0.35%
731-001	METAL HALIDE	250W MH/BALLAST	HOLOPHANE	EC-4117-L/MTB		286	284	0.70%
731-001	METAL HALIDE	250W MH/BALLAST	VALMONT	16G2319W18		286	300	-4.90%
733-001	METAL HALIDE	400W MH/BALLAST	N/A	N/A		445	445	
733-001	METAL HALIDE	400W MH/BALLAST	HOLOPHANE	EC-3204/120V		445	438	1.57%
733-001	METAL HALIDE	400W MH/BALLAST	HOLOPHANE	EC-3207/277V		445	440	1.12%
733-001	METAL HALIDE	400W MH/BALLAST	HOLOPHANE	EC-3208/480V		445	446	-0.22%
733-001	METAL HALIDE	400W MH/BALLAST	HOLOPHANE	EC-3209/MTB		445	442	0.67%
733-001	METAL HALIDE	400W MH/BALLAST	VALMONT	16G3309W18		445	460	-3.37%
737-001	METAL HALIDE	1000W MH/BALLAST	N/A	N/A		1070	1070	
737-001	METAL HALIDE	1000W MH/BALLAST	HOLOPHANE	EC-3216/120V		1070	1063	0.65%
737-001	METAL HALIDE	1000W MH/BALLAST	HOLOPHANE	EC-3219/277V		1070	1065	0.47%
737-001	METAL HALIDE	1000W MH/BALLAST	HOLOPHANE	EC-3220/480V		1070	1070	
737-001	METAL HALIDE	1000W MH/BALLAST	HOLOPHANE	EC-3221/MTB		1070	1065	0.47%
737-001	METAL HALIDE	1000W MH/BALLAST	VALMONT	16G5299W18		1070	1075	-0.47%

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
39-001	METAL HALIDE	1500W MH/BALLAST	N/A	N/A		1625	1625	
741-001	LP SODIUM	35W LPS/BALLAST	N/A	N/A		60	60	
743-001	LP SODIUM	55W LPS/BALLAST	N/A	N/A		85	85	
745-001	LP SODIUM	90W LPS/BALLAST	N/A	N/A		130	130	
747-001	LP SODIUM	135W LPS/BALLAST	N/A	N/A		180	180	
749-001	LP SODIUM	180W LPS/BALLAST	N/A	N/A		230	230	
751-001	HP SODIUM	35W HPS/BALLAST	N/A	N/A		45	45	
751-001	HP SODIUM	35W HPS/BALLAST	HOLOPHANE	EC-3178/120V		45	40	11.11%
751-001	HP SODIUM	35W HPS/BALLAST	VALMONT	17G7510		45	45	
753-001	HP SODIUM	50W HPS/BALLAST	N/A	N/A		60	60	
753-001	HP SODIUM	50W HPS/BALLAST	HOLOPHANE	EC-2893/120V		60	60	
753-001	HP SODIUM	50W HPS/BALLAST	HOLOPHANE	EC-3341-D/277V		60	60	
753-001	HP SODIUM	50W HPS/BALLAST	HOLOPHANE	EC-3331-D/MTB		60	60	
753-001	HP SODIUM	50W HPS/BALLAST	HOLOPHANE	EC-3344-D/480V		60	60	
753-001	HP SODIUM	50W HPS/BALLAST	VALMONT	17G8100		60	63	-5.00%
755-001	HP SODIUM	70W HPS/BALLAST	N/A	N/A		92	92	
755-001	HP SODIUM	70W HPS/BALLAST	HOLOPHANE	EC-2039-D/277V		92	94	-2.17%
755-001	HP SODIUM	70W HPS/BALLAST	HOLOPHANE	EC-2040-D/480V		92	90	2.17%
755-001	HP SODIUM	70W HPS/BALLAST	HOLOPHANE	EC-2666-D/MTB		92	93	-1.09%
755-001	HP SODIUM	70W HPS/BALLAST	HOLOPHANE	EC-2894/120V		92	83	9.78%
755-001	HP SODIUM	70W HPS/BALLAST	VALMONT	17G7119		92	95	-3.26%
57-001	HP SODIUM	100W HPS/BALLAST	N/A	N/A		130	130	
757-001	HP SODIUM	100W HPS/BALLAST	HOLOPHANE	EC-2048-D/277V		130	128	1.54%
757-001	HP SODIUM	100W HPS/BALLAST	HOLOPHANE	EC-2049-D/480V		130	130	
757-001	HP SODIUM	100W HPS/BALLAST	HOLOPHANE	EC-2728-D/MTB		130	128	1.54%
757-001	HP SODIUM	100W HPS/BALLAST	HOLOPHANE	EC2895-D/120V		130	128	1.54%
757-001	HP SODIUM	100W HPS/BALLAST	VALMONT	17G6119W18		130	135	-3.85%
759-001	HP SODIUM	150W HPS/BALLAST	N/A	N/A		190	190	
759-001	HP SODIUM	150W HPS/BALLAST	HOLOPHANE	BL-82/277V		190	185	2.63%
759-001	HP SODIUM	150W HPS/BALLAST	HOLOPHANE	BL-83/480V		190	188	1.05%
759-001	HP SODIUM	150W HPS/BALLAST	HOLOPHANE	BL-85/MTB		190	185	2.63%
759-001	HP SODIUM	150W HPS/BALLAST	HOLOPHANE	EC-1960-D/120V		190	180	5.26%
759-001	HP SODIUM	150W HPS/BALLAST	HOLOPHANE	EC-1963-D/277V		190	180	5.26%
759-001	HP SODIUM	150W HPS/BALLAST	HOLOPHANE	EC-1964-D/480V		190	185	2.63%
759-001	HP SODIUM	150W HPS/BALLAST	HOLOPHANE	EC-2729-D/MTB		190	180	5.26%
759-001	HP SODIUM	150W HPS/BALLAST	HOLOPHANE	EC-2896/120V		190	185	2.63%
759-001	HP SODIUM	150W HPS/BALLAST	VALMONT	17G1119W18		190	200	-5.26%
763-001	HP SODIUM	250W HPS/BALLAST	N/A	N/A		295	295	
763-001	HP SODIUM	250W HPS/BALLAST	HOLOPHANE	EC-3749-L/277V		295	291	1.36%
763-001	HP SODIUM	250W HPS/BALLAST	HOLOPHANE	EC-3750-L/480V		295	295	
763-001	HP SODIUM	250W HPS/BALLAST	HOLOPHANE	EC-3751-L/MTB		295	290	1.69%
763-001	HP SODIUM	250W HPS/BALLAST	HOLOPHANE	EC-3746-L/120V		295	286	3.05%
763-001	HP SODIUM	250W HPS/BALLAST	VALMONT	17G2239		295	300	-1.69%
7-001	HP SODIUM	400W HPS/BALLAST	N/A	N/A		450	450	
767-001	HP SODIUM	400W HPS/BALLAST	HOLOPHANE	BL-1/120V		450	441	2.00%
767-001	HP SODIUM	400W HPS/BALLAST	HOLOPHANE	BL-2/277V		450	446	0.89%

LUMINAIRE WATTAGE TABLE

Code	Fixture Type	Fixture Description	Manufacturer	Part Number	THD	Class Watts	Study Watts	DIF
767-001	HP SODIUM	400W HPS/BALLAST	HOLOPHANE	BL-3/480V		450	452	-0.44%
767-001	HP SODIUM	400W HPS/BALLAST	HOLOPHANE	BL-4/MTB		450	445	1.11%
767-001	HP SODIUM	400W HPS/BALLAST	VALMONT	17G3229W18		450	465	-3.33%
769-001	HP SODIUM	1000W HPS/BALLAST	N/A	N/A		1080	1080	
769-001	HP SODIUM	1000W HPS/BALLAST	HOLOPHANE	EC-4094/120V		1080	1080	
769-001	HP SODIUM	1000W HPS/BALLAST	HOLOPHANE	EC-4097/277V		1080	1070	0.93%
769-001	HP SODIUM	1000W HPS/BALLAST	HOLOPHANE	EC-4098/480V		1080	1055	2.31%
769-001	HP SODIUM	1000W HPS/BALLAST	HOLOPHANE	EC-4099/MTB		1080	1075	0.46%
769-001	HP SODIUM	1000W HPS/BALLAST	VALMONT	17G5219W18		1080	1100	-1.85%

APPENDIX A, EXHIBIT 2

MOTOR TABLES

Table 1

Three-Phase Motor Efficiency

Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC) Motors

Horsepower	1800 RPM 100% Load Factor Existing Efficiency	3600 RPM 100% Load Factor Existing Efficiency
1	0.740	0.740
1.5	0.722	0.772
2	0.780	0.780
3	0.798	0.793
5	0.831	0.819
7.5	0.838	0.841
10	0.850	0.848
15	0.865	0.868
20	0.875	0.872
25	0.880	0.879
30	0.881	0.870
40	0.894	0.879
50	0.904	0.890
60	0.903	0.895
75	0.908	0.801
100	0.916	0.918
125	0.918	0.909
150	0.923	0.921
200	0.933	0.931
250	0.941	0.941

Table 2

MOTOR PART LOAD EFFICIENCY TABLE
(PERCENT RATED LOAD EFFICIENCY)
MOTOR HORSEPOWER RANGE

% LOAD	0-1	1.5-5	10.0	15-25*	30-60*	75-100
0	0.0	0.0	0.0	0.0	0.0	0.0
5	20.0	22.6	34.5	48.5	63.5	78.2
10	38.7	41.8	55.1	71.0	79.6	88.0
15	50.7	56.0	70.1	80.5	86.8	92.9
20	60.0	67.8	80.5	88.1	92.4	96.7
25	67.3	77.9	86.2	92.3	95.0	97.8
30	74.7	85.2	89.6	95.8	97.4	98.9
35	79.0	91.3	93.1	97.6	98.5	99.4
40	83.3	95.7	95.4	99.4	99.7	100.0
45	86.0	99.4	97.1	100.0	100.1	100.2
50	88.7	101.1	97.7	100.5	100.5	100.5
55	90.0	101.6	98.8	100.8	100.6	100.5
60	91.3	102.6	99.3	101.0	100.8	100.5
65	92.6	102.7	99.6	101.2	100.9	100.5
70	94.0	402.7	100.0	101.5	101.0	100.5
75	95.3	102.3	100.0	101.7	101.1	100.5
80	96.3	101.6	100.1	101.4	100.9	100.4
85	97.2	101.5	100.2	101.0	100.6	100.3
90	98.1	101.1	100.1	100.7	100.4	100.2
95	99.1	100.5	100.1	100.3	100.2	100.1
100	100.0	100.0	100.0	100.0	100.0	100.0
105	100.2	99.4	99.9	99.5	99.5	99.5
110	100.5	98.9	99.6	99.0	99.1	99.1
115	100.8	98.3	99.3	98.6	98.6	98.7
120	101.0	97.4	98.8	98.1	98.2	98.2
125	101.3	97.1	98.6	97.6	97.7	97.8

Sources:

1) PG&E Application Note NO. 44-24-81
2) LOCAL GOVERNMENT ENERGY MANAGEMENT "High Efficiency Electric Motor Application" Published by WSEO, WAOENG-83-49.p.19
3) Data for 15 hp thru 25 hp and 30 hp thru 60 hp sized motors was obtained by interpolation.

APPENDIX A, EXHIBIT 3

APPENDIX A, EXHIBIT 3

Determination of Constant Load for Applications and Related Procedures

1. General

The following procedures have been developed to address a material lack of data regarding the constancy of motor loading for generic application types. To provide confidence in savings estimates in absence of such data, and to provide information that may support reduced measurement costs for future program years, the parties are willing to undertake this measurement effort under the DSM Plans.

In an individual facility prior to retrofit, sort the population of motors into application types expected to experience constant motor loads.

Application types will need to be sufficiently defined (with piping/valving diagrams, system schematics, control descriptions, etc.) to allow unambiguous classification of the application type, and transferability of test results to other motors in equivalent applications.

Examples of application types are as follows:

- HVAC supply fan motors serving similar types of HVAC units (e.g., terminal reheat, dual duct, etc.)
- Cooling water pumps, condenser water pumps, etc.
- Heating hot water pumps
- HVAC return fans serving similar HVAC units

2. Determining Constancy of Load for an Application During Year Following Installation

For a sample of facilities implementing a given application type, a test of up to one year in duration will be required to verify that the application is, in fact, a constant load application. A procedure will be developed for each generic application type, to vary the system load over its normal operating range (tons of cooling, units of process output per hour, etc.) for the system in which the motor is installed. This procedure for testing motor load constancy will provide metered data on the motor load and documentation showing varying system operating conditions to validate that, over the full range of system load, motor load remains constant. Details of such tests and the transferability of the results from one facility and application to others will be approved on a case-by-case basis by the Utility, BRC Staff and Rate Counsel, or by the NJ BRC.

The constancy of load of a given application subgroup shall be determined as follows:

a. After retrofit, measure the kW for all retrofit motors continuously or over a representative time period. If load is measured over a representative time period, the load must be measured over such representative period annually in order to confirm that the load has not substantially changed. In addition, measure hours of operation of each motor for a sample of motors pursuant to the Utility's Sampling Plan.

b. Measure kWh per hour over hourly increments over the test period for a sample of the motors in an application subgroup (e.g., chilled water pump motors) in conformance with the Utility's Sampling Plan. Certain motor applications (such as those with relatively short operating cycles) may require interval readings to minimize the statistical impact of short cycling (low readings will result from constant operation during part of a one hour period due to start-up or shut down). The judgement of the installer will determine whether hourly intervals will be adequate for each application subgroup. The interval used for data collection will be the same for all motors in a given sample.

c. If the variance for each motor in the sample is equal to 0 at a 90% confidence level using the Chi-square test, the constancy of load for the application is validated.

d. If, for any motor(s) in the sample, the variance exceeds 0, perform the following:

   i. Examine the data to determine whether the load for the motor is: (a) systematically variable; (b) represents a change in the motor's constant load during the test period; (c) any system anomaly.

ii. If the load on the motor(s) is systemically variable, install hourly meters on the population of motors for a period of not less than one month to determine the appropriate classification and measurement plan (e.g., Method 3) for each motor. Adjust savings for all motors during the test period according to Paragraph 3 below.

iii. If the variation represents a consistent change in the motor's constant load, then investigate and document the cause for the change. Then rerun the test on the sample of motors. If a motor in the sample exceeds the limit set forth in Paragraph 2.c, then follow the procedures in Paragraph 2.d.ii. If the motors all pass the test in Paragraph 2.c., then constancy is established.

iv. If a system anomaly is the source of variation and can be explained, by a logical reason, the entire sample may not need be invalid. Inspection of the data may reveal viable solutions acceptable to the Utility, NJ BRC Staff, and Rate Counsel. After any satisfactory explanation, the motors shall be re-tested in accordance to Paragraph 2.c above.

e. If for any sampled motor, the initial measured kW from Paragraph 2.a above varies from its mean (as computed for each sample in accordance with Paragraph 2, above) by more than ±10%, then reaffirm all load measurements for the population of motors, and recompute savings for the test period using the update values. If the change is not unique to the motor, then reaffirm all load measurements (Paragraph 2.a) for the population. Adjust savings for all motors during the test period according to Paragraph 3.

f. If there are any significant changes to the configuration or process, constancy must be re-established pursuant to this Exhibit 3, Appendix A.

3. Calculation of Energy and Capacity Savings

a. If the application is constant, then the calculation of energy and capacity savings shall be done in accordance with Method 1 using the procedures specified in Method 1, without adjustment.

b. If the application is not constant, then implement a measurement plan (including additional metering as necessary) consistent with Method 3, and adjust the energy and capacity savings estimated during the test period as follows:

$$kWh_A = kWh_B * \frac{\sum kWh_m}{\sum kW_m * Hr_m}$$

WHERE:

kWh_A = Adjusted population energy savings.

kWh_B = Estimated population energy savings before adjustment assuming constant load.

kW_m = Demand measured for sample motors, at the start of the test period, pursuant to Paragraph 2.a above.

kWh_m = Metered kWh use over the test period for each motor in the sample.

Hr_m = Hours measured for each sample motor.

APPENDIX B: MEASUREMENT EXAMPLES FOR METHOD 1

EXAMPLE 1 TO METHOD 1

Inefficient Lighting Fixtures Are Retrofitted with Efficient Lighting Measures

1. TYPES OF MEASURES

The measures addressed in this Example 1 improve the efficiency of lighting fixtures and do not involve a change in the operating hours of such lighting fixtures.

2. MEASUREMENT METHODOLOGY

a. Establish baseline connected load (kW) by summing the Utility accepted connected loads for each existing luminaire type to be replaced or modified. Accepted connected load shall be shown in the Luminaire Wattage Table set forth in Appendix A, Exhibit 1, and updated by the Utilities in accordance with this Protocol and procedures accepted by the NJ BRC Staff and Rate Counsel.

b. Establish post-installation connected load (kW) with respect to the installed luminaires as the sum of either the Utility accepted connected loads for luminaires (as derived from the Luminaire Tables set forth in Appendix A, Exhibit 1) or the actual measured kW of the installed luminaires (or sample thereof) pursuant to Method 1, Paragraph 2.c.i, of the Protocol. Where an Utility or ESCO chooses to derive kW from the actual measured kW of the installed luminaires (or sample thereof) with respect to a particular Utility service territory, then such Utility or ESCO must apply this same methodology to all facilities and installations in such Utility service territory. Compare pre- and post-installation connected loads to determine load reduction.

c. Concurrent with installation of lighting measures, install permanent metering on individual devices or control circuits, or a sampling of devices or control circuits in accordance with Utility's Sampling Plan. Measure operating hours after retrofit in accordance with the metering requirements set forth herein and with the Utility's Verification Procedures.

d. Measure energy savings as the product of connected load reduction from Step b and run hours for each utility time period from Step c. Where multiple run-hours meters are used to monitor an end use pattern, use a simple or weighted (based on connected load) average of run-hour meter readings, if differences exist, to determine run hours for each group.

e. The interaction affect on space conditioning for indoor lighting will be 5% of the energy and capacity savings directly resulting from lighting measures installed in conditioned space. This value will be examined over the next two years and may be modified for future Utility program fillings.

f. Use the following formulae for the computation of energy savings and connected load reduction:

i. kWh savings shall be determined by:

$$kWhpd = kWd * hrspd * (1 + IF)$$

Where:

kWhpd is the kWh savings for the each Utility Time Period and

hrspd is the metered run time for each Utility Time Period after installation of lighting measures for a representative sample of circuits resulting in kwd as set forth in a Utility's Sampling Plan.

ii. Connected load reduction shall be determined by:

$$kWd = kWd_{pre} - kWd_{post}$$

Where:

kWd is the reduction in connected load resulting from the installation of the lighting measures;

kWd_{pre} is the connected load of the device (or the sum total of all applicable devices) prior to measure installation as determined in accordance with Step 2.a above; and

kWd_{post} is the connected load of the device (or the sum total of all applicable devices) after measure installation as determined in accordance with Step 2.b above.

iii. IF is the value of the Interactive Factor accounting for reduced HVAC consumption resulting from decreased indoor lighting wattage. The IF is to be applied only where lighting measures are installed in conditioned space. This value shall be fixed at 5% of the energy and capacity savings directly resulting from lighting measures installed in conditioned space. This value will be examined over the next two years and may be modified for the next Utility program filing.

g. Capacity savings shall be measured by energy savings over a specified period of time during which a Utility typically achieves its system seasonal peaks. Use the following formula to determine capacity savings:

Capacity Savings (kW) = kWhcp / Total Capacity Period hours

Where:

kWhcp is the energy savings during the Utility's applicable capacity period or periods.

The capacity period or periods shall be determined by each Utility as approved by the NJ BRC.

3. SAMPLE CALCULATION OF SAVINGS

a. Assumptions:

Luminaire Code xxx for pre-installation fixture configuration: kWxxx 188W
Luminaire Code yyy for post-installation fixture configuration: kWyyy 160W

Total measured on-peak run hours:	204 hrs
Total measured off-peak run hours:	96 hrs
Measured hours for Capacity Period:	80 hrs
Total Capacity Period hours for Utility Time Period:	88 hrs
Number of luminaires	100

b. Calculate load reduction

kWd	=	# of luminaires * (kWxxx - kWyyy)
	=	100 * [(188/1000) - (160/1000)]
	=	2.8 kW

c. Calculate energy savings

kWhpd = kwd * hrspd * 1.05

i.	On-peak kWh:	2.8 kW * 204 hours * 1.05	=	600 kWh
ii.	Off-peak kWh:	2.8 kW * 96 hours * 1.05	=	282 kWh
iii.	Total kWh savings:		=	882 kWh

d. Calculate capacity savings

i. Peak Capacity
Time Period kWh: 2.8 * 80 hours * 1.05 = 235 kWh

ii. Capacity Savings = kWhpd ÷ total peak capacity period hours

$$= \frac{235\ \text{kWh}}{88\ \text{hours}}$$

$$= 2.67\ \text{kW}$$

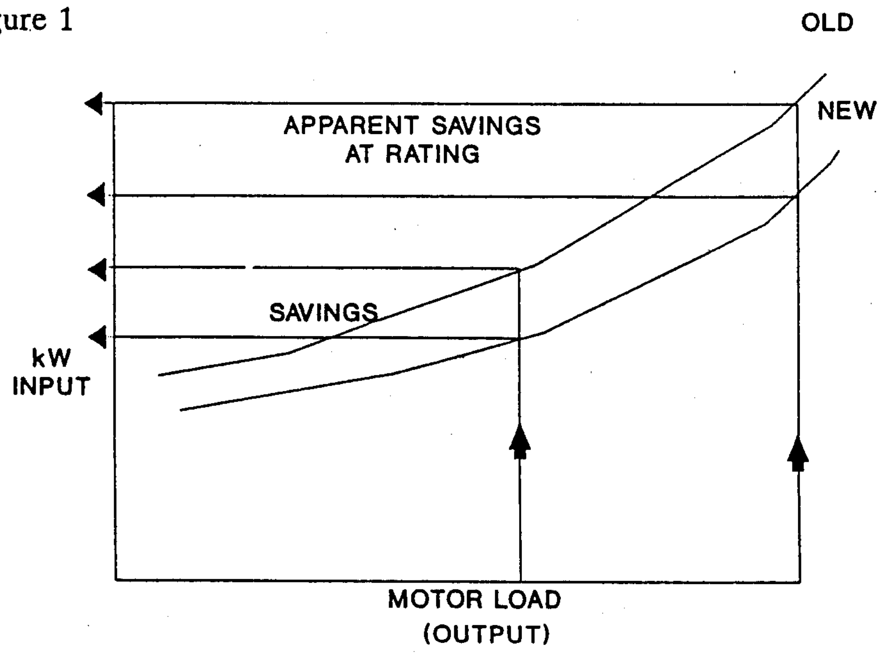
EXAMPLE 2 TO METHOD 1

Pump Motor is Replaced with a New Energy Efficient Motor in Constant Load Situation

1. GENERAL DESCRIPTION OF OPPORTUNITY

An existing constant speed pump, defined pursuant to Appendix A, Exhibit 3, has constant load over hours of use. Improvement in efficiency is possible by replacing the existing motor with an energy efficient motor. The magnitude of this savings potential is based on the difference between new and old motor efficiencies and the load on the motor. In this example, no other efficiency to gallons pumped is possible.

Figure 1



The savings are shown in Figure 1 and are determined by subtracting the assumed kW before retrofit from the kW after retrofit by using manufacturers curves and using measurement of kW after retrofit to determine savings.

2. FIELD SITUATION

Pump motor is standard 25 HP motor will full load efficiency of 87%. To be replaced with energy efficient motor of 94% efficiency at full load. No modification to system load is possible.

3. METHOD

a. Obtain manufacturers curves of kW input versus % motor full load and nameplate efficiency at full load as available. If not available, use default tables including table de-rating nameplate efficiency at part load. Priority of use:

   i. Manufacturer's performance curve
   ii. Nameplate efficiency, with de-rating factors from Table 2 in Appendix A, Exhibit 2.
   iii. Default efficiency from Table 1 with/without de-rating from Table 2 in Appendix A, Exhibit 2.

b. Measure kW and hours of operation after motor retrofit continuously over a representative time period.

c. Determine constancy of load pursuant to Appendix A, Exhibit 3.

d. If load is constant, calculate savings pursuant to this Example; otherwise, see Appendix A, Exhibit 3, for required procedures.

4. SAMPLE CALCULATION OF SAVINGS

a. Assumptions:

Existing motor HP:	25 Hp
New motor HP:	25 Hp
New motor efficiency:	94%
Existing motor efficiency:	87%
Measured operating hours	
On peak hours:	300 hrs
Off peak hours:	400 hrs
Capacity period hours:	40 hrs
Total Capacity Period hours:	88 hrs
De-rating of existing motor before (from Table 2 in Appendix A, Exhibit 2) at 80% load:	101.4%

b. Calculate full load kW input to new motor from nameplate data, manufacturers efficiency rating. (See assumptions above for the source of values used in the formula below.)

$$\frac{\text{motor HP} * .746 \text{ kW/hp}}{\text{motor EFF}} = \frac{25 \text{ hp} * .746}{.94}$$

$$= 19.84 \text{ kW}$$

c. Measure kW after retrofit in accordance with a Utility's Verification Procedures.

$$\text{kW} = 15.9$$

d. Calculate kW before retrofit. (See assumptions above for the source of values used in the formulae below.)

i. Compute new motor loading

$$\frac{\text{Measured kW}}{\text{Full load kW}} = \frac{15.9}{19.84}$$

$$= 80\% \text{ Full Load}$$

ii. Compute existing motor kW prior to retrofit

$$\frac{\text{HP * \% Full load *.746}}{\text{EFF * De-rating @ \% Full load}} = \frac{25 * .80 * .746}{.87 * 1.014}$$

$$= 16.91 \text{ kW}$$

e. Calculate kWh savings by multiplying kW saved by hours of operation

Savings = Hours * (kW Before - kW After)

On peak: = 300 hours * times (16.91 kW - 15.9 kW)

= 303 kWh

Off peak: = 400 hours * (16.91 kW - 15.90 kW)

= 404 kWh

f. Calculate Capacity Savings

$$= \frac{40 \text{ hours} * (16.91 \text{ kW} - 15.90 \text{ kW})}{88 \text{ hours}}$$

= 0.46 kW

3. METHOD

Pursuant to the methodology described in Appendix A, Exhibit 3:

a. Measure kW of all existing motors for representative time period in accordance with a Utility's Verifcation Procedures.

b. Measure kW of all new motors.

c. Monitor kW and operating hours on representative sample of motors pursuant Utility's Sampling Plan and pursuant to the procedures set forth in Appendix A, Exhibit 3, to determine the constancy of load.

d. If load is constant, calculate savings pursuant to this Example; otherwise, see Appendix A, Exhibit 3, for required procedures.

4. SAMPLE CALCULATION OF SAVINGS

a. Assumptions:

Existing motor HP:	25 Hp
New motor HP:	15 Hp
Existing motor full load efficiency (based on nameplate):	87%
New motor full load efficiency (based on nameplate):	94%
Operating hours (measured):	
On peak hours:	70 hrs
Off peak hours:	700 hrs
Capacity period hours:	60 hrs
Total Capacity Period hours:	88 hrs
Existing motor kW @ load (measured):	17.15 kW
New motor kW @ load (measured):	8.3 kW

b. Measure kW of existing and new motors in accordance with a Utility's Verification Procedures.

i.	Existing motor	=	17.15 kW
ii.	New motor (based on hourly metered values)	=	8.3 kW

c. Calculate Kwh savings for the period by multiplying kW saved by hours of use:

kWh savings	=	Hours * (kW existing - kW new)
Off peak	=	700 hours * (17.15 kW - 8.3 kW)
	=	6195 kWh
On peak	=	70 hours * (17.15 kW - 8.3 kW)
	=	620 kWh

d. Calculate capacity savings

kW	=	kWhpd / Capacity Period Hours
	=	60 hours * (17.15 kW - 8.3 kW) / 88 hours
	=	6.03 kW

APPENDIX C: MEASUREMENT EXAMPLES FOR METHOD 2

[INTENTIONALLY BLANK]

APPENDIX D: MEASUREMENT EXAMPLES FOR METHOD 3

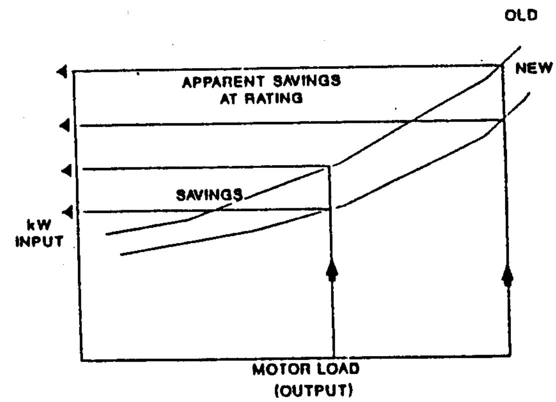
EXAMPLE 1
TO
METHOD 3

Pump Motor is Replaced with a New Energy Efficient Motor in Varying Load Situation

1. GENERAL DESCRIPTION OF OPPORTUNITY

Existing constant speed pump has varying load over hours of use. Improvement in efficiency is possible by replacing motor. The magnitude of this savings is based on the difference between new and old motor efficiencies which vary with the load on the motor.

Figure 1



Efficiency curves for the pump operating with existing and new energy-efficient motors are shown in Figure 1. kW savings are determined by subtracting the kW before the retrofit from the measured kW after the retrofit. Motor efficiency curves are developed from manufacturer curves, or if not available for the existing motor, default tables with appropriate de-rating factors set forth in Appendix A, Exhibit 2 (Tables 1 and 2), shall be applied. kWh savings is the difference in kW between the existing and new motor performance, as shown on the curve, at any operating point, summed over time.

2. FIELD SITUATION

Existing pump motor is standard 25 HP motor with full load efficiency of 87%. To be replaced with energy efficient motor of 94% efficiency at full load. No modification to system load is possible.

3. METHOD

a. Obtain manufacturer's curves of kW input versus % motor full load and nameplate efficiency at full load as available. If not available, use default tables including table de-rating nameplate efficiency at part load as set forth in Appendix A, Exhibit 2 (Tables 1 and 2). Priority of use:

   i. Manufacturer's curve kW in versus % motor full load
   ii. Nameplate efficiency in conjunction with de-rating table (Table 2 of Appendix A, Exhibit 2)
   iii. Default efficiency table (Table 1 of Appendix A, Exhibit 2) with de-rating table (Table 2 of Appendix A, Exhibit 2)

b. Measure kW and hours of operation after installation continuously over the life of the claimed benefits.

c. Determine equivalent kW of existing motor for the time interval.

d. Calculate savings by summing the difference between kWh before the retrofit and measured kWh after installation of the new efficient motor in accordance with the following formula.

$$S = \sum_{i=1}^{n} [(kW_{Bi} - kW_{Ai}) * H_{Ai}]$$

Where:

S	=	Total kWh savings
i	=	Interval
n	=	Number of intervals
kW_{Bi}	=	kW input to existing motor based on manufacturer's curve or the Default Tables in Appendix A, Exhibit 2 (Table 2) at measured load after retrofit
kW_{Ai}	=	Measured input after retrofit
H_{Ai}	=	Time (in hours) at load kW_{Ai}

4. EXAMPLE

a. Assumptions

Existing motor Hp:	25 Hp
New motor Hp:	25 Hp
Existing motor full load efficiency (based on nameplate):	87%
New motor full load efficiency (based nameplate):	94%
Operating hours (measured):	70 hours
New motor kW load (measured):	6.0 kW
Existing motor kW @ 30.2% motor load (calculated):	6.76 kW

b. Compute baseline motor (kW_{Bi})at measured load of new motor. Given new motor full load efficiency of 94%. Use motor performance curves for existing motors to determine savings consistent with the methodology described in Method 1, Paragraphs 2.b.iii and 2.b.iv, of the Protocol.

i. Full load kW $= \dfrac{25 \text{ Hp} * .746 \text{ kW/hp}}{94\%} = 19.84$ kW

ii. Motor load percent $= \dfrac{\text{Measured kW}}{\text{Full load kW}} = \dfrac{6.0 \text{ kW}}{19.84 \text{ kW}}$

$= 30.2\%$

iii. Baseline motor (@87% full load efficiency) and 95.8% part load derating factor from Tables 1 and 2 in Appendix A, Exhibit 2 for a 25 hp motor @30.2% load:

$$kW_{Bi} = \frac{\text{Hp} * \%\text{ Full Load} * .746\text{kW/hp}}{\text{EFF @ Full Load} * \text{derating factor}}$$

$$= \frac{25 * .302 * .746}{.87 * .958}$$

$$= 6.76 \text{ kW}$$

c. Compute energy savings

$$(kW_{Bi} - kW_{Ai}) * H_{Ai} = (6.76 \text{ kW} - 6.0 \text{ kW}) * 70 \text{ hours}$$

$$= 53 \text{ kWh}$$

EXAMPLE 2 TO METHOD 3

Constant Load Pump Motor is Retrofitted with Variable Frequency Drive to Satisfy Same End Use Requirement

The following example is set forth as an illustrative example only. The Utility, BRC Staff and Rate Counsel will review and, if acceptable, approve the application of a methodology like that set forth in this example when such specific example and methodology are proposed.

1. GENERAL DESCRIPTION OF OPPORTUNITY

Existing pumping system provides fixed gallons per minute to end use which requires varying gallons over an operating range (e.g., chilled water supply). Improvements in efficiency are possible by installing a variable frequency drive on the motor powering the pump.

Figure 1

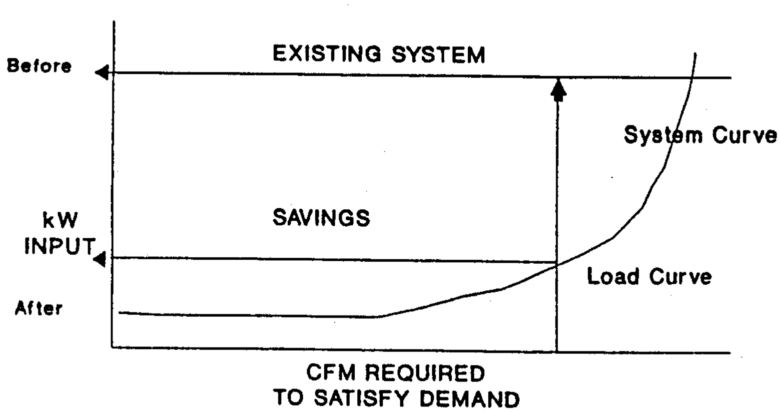
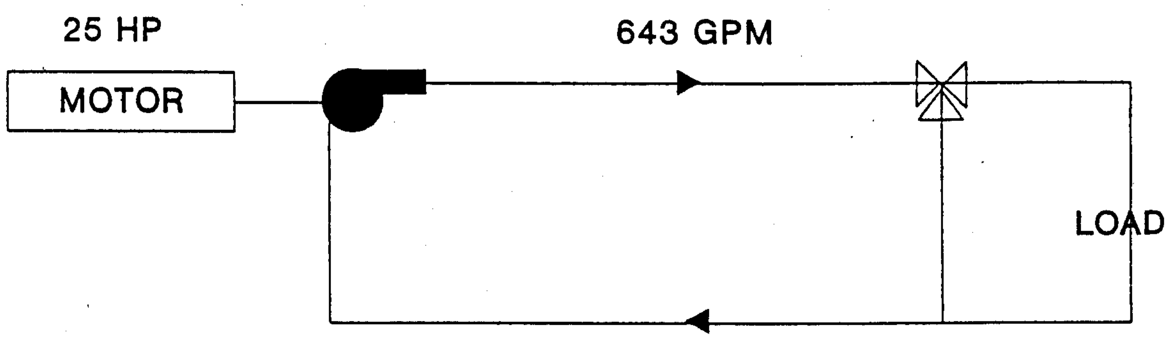


Figure 1 illustrates the savings that would occur from replacing a constant volume pumping station with a variable volume pumping station in satisfying a variable end use requirement. The savings are determined over time by tracking kW and hours and integrating the product of these two quantities after retrofit and subtracting this total from the load that would have occurred with the constant volume system.

2. FIELD SITUATION

A 25 HP motor drives a pump supplying design flow rate of 643 gpm to a variable load. Control is currently by a three way bypass valve as shown in Figure 2.

Figure 2



3. MEASUREMENT DESCRIPTION

a. Measure kW of existing motor and determine whether it is constant in accordance with the methodology set forth in Appendix A, Exhibit 3. If constant, continue with next steps; if not constant, the methodology in this Example does not apply.

b. Measure kW and operating hours after installation of VSD, continuously over the life of the claimed benefits.

c. Calculate savings by summing the difference between kWh before the retrofit and measured kWh after installation of the VSD in accordance with the following formula.

$$S = \sum_{i=1}^{n} [(kW_B * T) - (kW_{Ai} * T)]$$

WHERE:

S	=	Total kWh savings
i	=	Interval
n	=	Number of intervals
kW_B	=	Electric input before (kW)
kW_{Ai}	=	Electric input (kW) in interval i
T	=	Time (in hours) in interval

4. SAMPLE CALCULATION OF SAVINGS

a. Assumptions:

Measured load before installation of VSD (average of measured non-zero values over representative time period and in accordance with Appendix A, Exhibit 3):	12.9 kW
Time (in hours) in interval:	.25 hrs
Measured kW of VSD in interval:	9.0 kW

b. Calculate energy savings in interval

(kW for existing motor * Time) - (kW of VSD * Time)

= (12.9 kW * 0.25 hours) - (9.0 kW * 0.25 hours)

= 0.975 kWh

c. Calculate energy savings over each Utility Time Period as follows:

$$S = \sum_{i=1}^{n} s_i$$

$$= 0.975 + \ldots.$$

Where:

S = energy savings in Utility Time Period

s_i = Energy savings in interval

EXAMPLE 3 TO METHOD 3

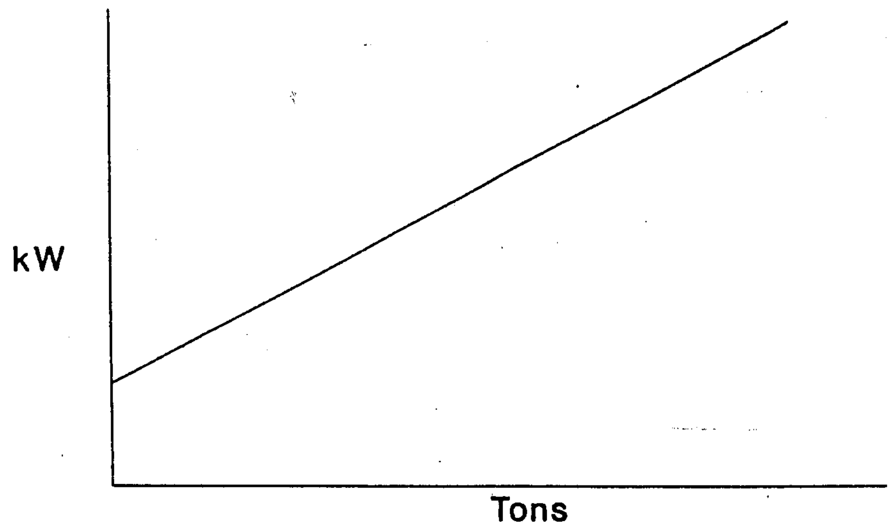
Chiller System Efficiency Is Improved

The following example is set forth as an illustrative example only. The Utility, BRC Staff and Rate Counsel will review and, if acceptable, approve the application of a methodology like that set forth in this example when such specific example and methodology are proposed.

1. GENERAL DESCRIPTION

- kW/ton is improved by all of the following: resetting chilled water supply temperature, resetting condenser water temperature, and installing heat exchanger in chilled water loop to provide free cooling when outdoor conditions allow.
- kW input per ton of cooling produced can be measured over a base period of operation demonstrating the full range of expected existing operating conditions (condenser water, tonnage)
- The existing system's control of condenser water supplied to the chiller from the cooling tower is set at 85°F.
- Chilled water is supplied at 45°F
- GPM is constant or has been determined to be constant in accordance with Appendix A, Exhibit 3

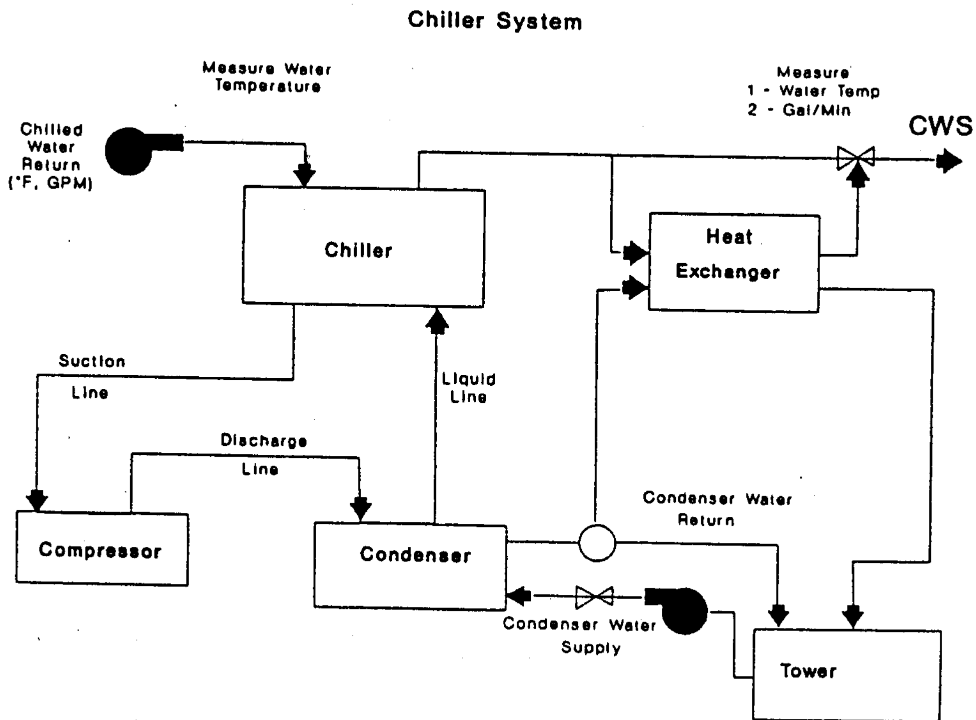
Figure 1: kW per Ton at Design Condenser Water Temperature



2. FIELD SITUATION

A 150 ton centrifugal chiller operates with a cooling tower set to provide constant 85°F condenser water back to the chiller. Current chilled water is supplied at 45°F when the chiller is in operation. Retrofit includes control system with reset of chilled water and condenser water with outside air wet bulb temperature. In addition, system load is supplied by a heat exchanger which uses condenser water. As chilled water temperature is raised for lighter loads or as condenser water temperature is decreased with increased tower capacity at lower wet bulb temperatures, chiller efficiency per ton increases. These improvements all reduce the kW/ton rate of energy use. Heat exchanger is used to replace the load supplied by the chiller at low wet bulb temperatures.

Figure 2: Chiller System



3. MEASUREMENT DESCRIPTION

a. Collect data over range of system chiller operating conditions (loads). A field developed chiller specific performance curve will be developed using continuous monitoring of the following data gathered before retrofit:

i. CWS °F (Chilled Water Supply Temperature) = 48°
ii. CWR °F (Chilled Water Return Temperature) = 55°
iii. CWS GPM (Gallons Per Minute Supplied, Chilled Water) = 345
iv. kW_{in} (kW Load on Chiller)
v. CS°F (Condenser Water Supply to Chiller Temperature)

Data will be gathered over the existing range of operating conditions of the chiller prior to retrofit. Duration of measurement shall be sufficiently long to capture anticipated load ranges of chiller.

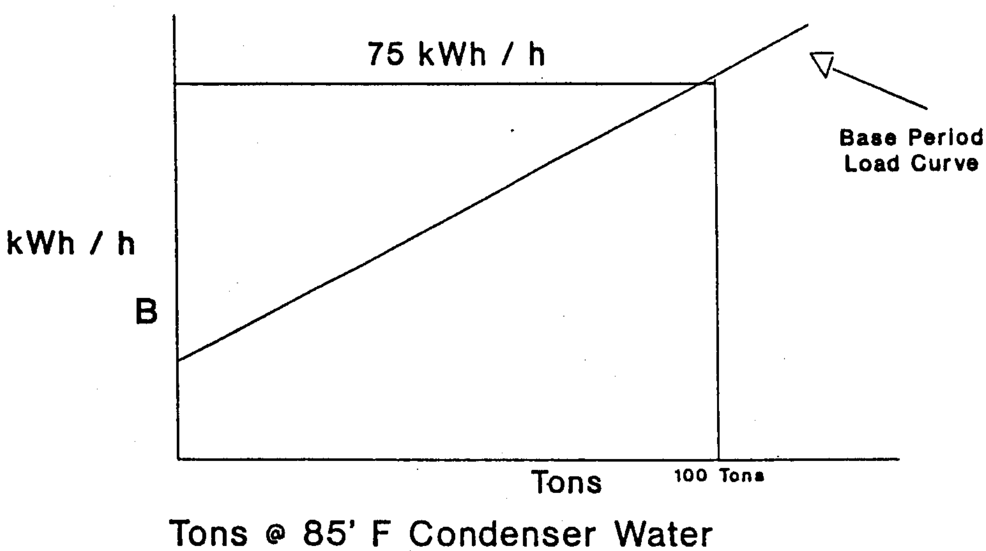
b. Develop the chiller performance curve(s) based on kW per ton at appropriate condenser water supply temperatures. Use ultrasonic measurement of CWS GPM to confirm design gallons per minute for a representative range of operating conditions.

Determine constancy of load in accordance with Appendix A, Exhibit 3.

c. After retrofit measure system tons (Figure 2) and chiller kW_{in} continuously.

d. Periodically, based on Utility Sampling Protocol, recalculate chiller "Base Load Curve at pre-existing operating conditions. Return controls to previous set points. By pass heat exchanger. Recreate Base Period Load Curve.

Figure 3: Field Developed Base Period Chiller Curve



4. CALCULATION OF SAVINGS

a. Measure tons during each Chiller Operating Period

$$\text{Tons/Hr.} = \frac{\text{GPM} * (60\ \text{min/hr.} * 8.346\ \text{BTU/gal.}) * (\text{CWR°F-CWS°F})}{12{,}000\ \text{Btu/ton}}$$

$$= \frac{345\ \text{GPM} * 500 * (55°\text{F}-48°\text{F})}{12{,}000\ \text{Btu/ton}}$$

$$= 100$$

b. Measure kWh during any Chiller Operating Period

$$kWh_A = 50$$

c. From "Field Developed" Chiller Specific Performance curve, determine what KWh would have been under previous operating parameters (this example assumes 85°F condenser water supply temperature was not reset)

d. Calculate energy savings as follows:

$$S = \sum_{i=1}^{n} [(kW_{Bi} * T) - kWh_{Ai}]$$

WHERE

S = Energy savings over measured range
i = Interval
n = Number of time intervals in evaluation period
kW_{Bi} = kW that would have been used over interval i, from performance curves
kWh_{Ai} = kWh that was used over interval i
T = Time (hours) in interval i

$$S = 75\ \text{kWh} - 50\text{kWh} + \ldots$$

$$= 25\ \text{kWh} + \ldots$$

NOTE:

1. Energy savings will be measured over each Utility Time Period.

2. Demand savings shall be the average hourly savings measured during the utility defined peak window for each month.

3. Regression analysis can be used to determine kW per ton relationship based on statistical criteria for regression acceptance.

4. Flow constancy (of CWS GPM) is determined by Paragraph 3.b of this Example 3. If constancy is not demonstrated, flow must be measured as well as temperature difference between supply and return chilled water unless alternate method is approved by all related parties.

EXAMPLE 4 TO METHOD 3

Sewage Lift Station Pump and Motor is Equipped with a Variable Frequency Drive (VFD)

The following example is set forth as an illustrative example only. The Utility, BRC Staff and Rate Counsel will review and, if acceptable, approve the application of a methodology like that set forth in this example when such specific example and methodology are proposed.

1. GENERAL DESCRIPTION OF OPPORTUNITY

An existing sewage pumping station motor is cycled on and off using level controller in the wet well. Pump operating hours are a function of the sewage inflow to the wet well. The opportunity consists of installation of a VFD device to operate the lift station motor at varying speeds (varying horsepower input to the pump) so that the wet well level and pump flow profile operates at the optimum point on the pumping efficiency curve. The efficiency is measured in kilowatt hours per million gallons (kWh/Mgal) pumped, pre and post the VFD retrofit.

The lift station pumping characteristics are shown in Figure 1 which describes the sewage in-flow profile and the resulting pump operating characteristics. The pump cycles on and off to empty the wet well. Figure 2 describes the variable flow characteristics achieved with VFD drive. The in-flow rate is matched to the pump operating profile to provide for the optimum lift efficiency at all times. Energy and capacity savings result from reduction in dynamic head and lift by maintaining constant wet well levels.

Figure 1: Lift Station Pumping Characteristics

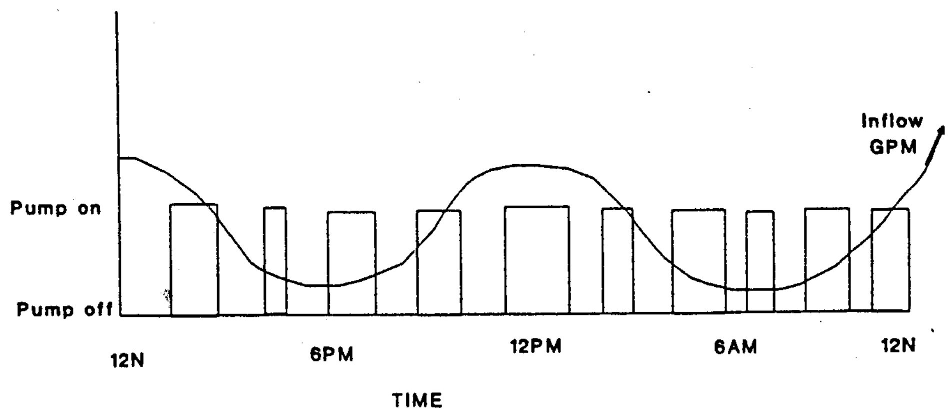
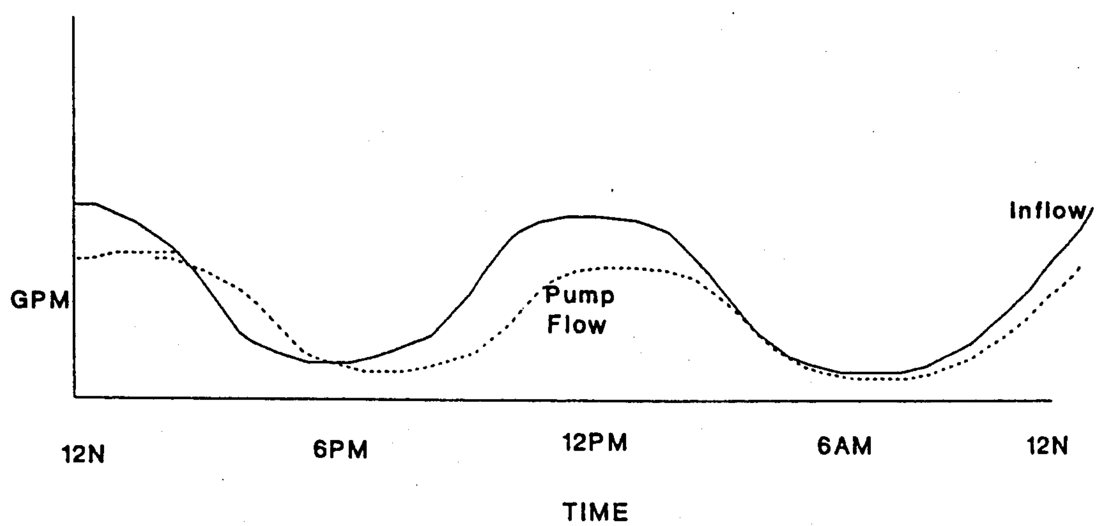


Figure 2: Variable Flow Characteristics After VFD Installation



2. FIELD SITUATION

The existing lift station pump and motor combination(s) are measured for a representative period as determined by process parameters, during which both pre-implementation energy measurement (kilowatt hours) are obtained, and total number of gallons pumped are recorded. The measurement period will reflect the full range of operating conditions. Sewer system load (gallons of in-flow) will vary depending on weather and sewage use conditions.

Establish a Load Curve that shows the relationship of energy input (kWh) and millions of gallons pumped (Mgal). The relationship between the pre-implementation kWh and the million gallons of sewage pumped can be determined through a regression analysis using the appropriate statistical tests set forth in the Protocol.

3. MEASUREMENT DESCRIPTION

a. Install a kilowatt hour recording device on the pump to record total kilowatt hour and kW demand over the the pre-installation measurement period. Unless otherwise approved, where there is one measurement of output per cycle, a minimum of 30 cycles shall be used. Utilizing sewage lift station operating log data (flow meters), identify periodic flows to correspond with the periodic kilowatt hour station energy use. Using regression analysis determine the relationship between energy consumed (kWh) and sewage pumped (Mgal).

b. i. Variable frequency drive device is subsequently installed on the system together with a new level controller (to obtain constant wet well elevation).

ii. Measure kilowatt hours and station flow data continuously for the life of the claimed benefit.

4. SAMPLE CALCULATIONS OF SAVINGS

a. Results from pre-installation regression:

i. Model:

kWh = a + (b * output) (where output is million gallons pumped)

= 18 + (265 * output (Mgal))

ii. T-statistic:

a = 5.7

b = 4.6

iii. Correlation co-efficient (R^2) :

R^2 = 92.3%

iv. Range of model validity:

0 to 45 Mgal

b. Post-installation measureed output:

Output = 29,635,200 gallons

Post-installation energy consumption:

Measured energy use = 4,838 kWh

c. Computation of energy savings

i. Using the regression analysis developed for the pre-installation system and the current flow determine the amount of energy the old system would have required.

kWh = 18 + (265 * output)

kWh = 18 + (265 * 29.6352 Mgal)

= 7,871 kWh

ii. Actual post-installation measurements show an electrical consumption of 4,838 kWh.

iii. Savings for this measurement period is:

kWh Savings = Baseline Calculation - Actual Measurement

= 7,871 - 4,838

= 3,033 kwh

EXAMPLE 5
TO
METHOD 3

Process Change Application

The following example is set forth as an illustrative example only. The Utility, BRC Staff and Rate Counsel will review and, if acceptable, approve the application of a methodology like that set forth in this example when such specific example and methodology are proposed.

1. GENERAL DESCRIPTION OF OPPORTUNITY

The measures addressed in this example improve the efficiency of electric end-use load that have a variable output. These measures can focus on individual pieces of equipment, production system departments, or entire facilities dependent on the process change. Each project must be considered as site specific in the preparation of the measurement plan.

2. MEASUREMENT DESCRIPTION

Proposed savings methodology for this class of measures is as follows:

a. Prior to installation of the measure:

   i. Conduct recording wattmeter measurements of the electrically powered system over a representative operating period before applying the efficiency measure to the system. Electrical data will be measured at the point which best represents the energy efficiency improvement measure. Historical data, including operating logs of kW readings for major equipment, may also be utilized to supplement the analysis, if available and if of adequate quality and reliability.

   ii. Measure system output ("Output") produced over the same operating and/or historical period. Typically, Output can be units of production, volume of input materials, or other units directly related to the energy use of the system affected by the efficiency measure and for which reliable records are maintained.

iii. Develop a Load Curve which reflects a pre-installation kW versus Output relationship. This curve can be developed using a regression analysis from acceptable historical and/or operating measurements, and may incorporate other relevant measured variables (such as weather). This Curve will be used to establish baseline electrical consumption for savings calculations, provided the regression satisfies the appropriate statistical test set forth in Method 3 of the Protocol.

b. After installation of the efficiency measure, compute the Post-installation Consumption in the following manner:

i. Record and/or measure the Output produced over the life of the claimed savings.

ii. Obtain the baseline electrical consumption from the Load Curve developed in Step 2.a.iii.

iii. Measure actual electrical consumption of the electrically powered system(s) after the installation of the efficiency measure. Measurements will take place at the same level as the measurements taken in Step 2.a. A recording wattmeter will be utilized to measure actual electrical consumption for the life of the claimed benefits.

c. Compute actual energy and demand savings as the difference between the baseline electrical consumption calculated in Step 2.b.ii above and the actual electrical consumption measured in Step 2.b.iii above integrated over the relevant rating period and month/season for energy, and averaged over the utility defined peak window for demand (see savings computation below).

3. DURATION OF MEASUREMENTS

The duration of measurement required to complete Step 2.a above will be determined for each measure application depending on the specific characteristics of the host process being addressed. In general, duration will be based on the minimum cycle time over which the device affected by the measure is subjected to the full range of system Output typical for the process with which the device is associated and providing sufficient data points in conformance with Method 3, Step 2.b. Some technologies and/or applications may require an extended duration of measurement. For each host facility, a proposed duration of measurement plan will be submitted to the utility for review and approval prior to proceeding with measure implementation. Measurement following measure installation shall be done on a continuing basis for the life of claimed benefits.

4. SAMPLE CALCULATION OF SAVINGS

The following is an illustration of the measurement procedure for a process change.

ABC Corporation is a metals fabrication plant and has a heat treatment facility. They are proposing to change the electric furnace to a more efficient design. The change will allow ABC Corporation to achieve the same levels of production with a more efficient electrical process.

Data was collected over a period of time, and in a manner conforming with Protocol requirements as specified in Method 3.

Historical data and recording wattmeters are utilized to obtain electrical consumption. Production records are reviewed to determine Units Produced during the time periods that electrical consumption data is collected. A review of this data shows that there is a statistical relationship between electrical consumption (kWh per 1,000 Units Produced) and Units Production, meeting the requirements of Method 3, Step 2.b.

Statistical Results: Baseline Model

i. Model form:

kWh = a + (b * 1000 units produced)

= 356 + (4.91 * 1000 units produced)

ii. T-Stat results

a: T-Stat = 2.5

b: T-Stat = 4.1

iii. Correlation coefficient (R^2): 85.4%

iv. Range of model validity:

0 - 500,000 units/hour

The new furnace is then installed. After the furnace has been installed, post-installation data is collected. This data collection will consist of electrical consumption using a recording wattmeter and Units Produced from production records.

Savings Computation

Savings are then calculated using the difference between the Baseline Model and actual data as follows:

After implementation, measure output (units produced) and input (kWh/hr) continuously. For a one-hour measurement interval, 320,000 units are produced.

A. Compute baseline use

From the baseline model, it is determined that prior to the installation of the furnace it would have taken:

$$kWh_B = 356 + (4.91 * 320 \text{ k Units produced})$$

$$= 1{,}927.2 \text{ kWh}$$

B. Measure post-installation use

Actual wattmeter recordings show that after the furnace is installed, it takes only 1,716 kWh to produce the 320,000 units:

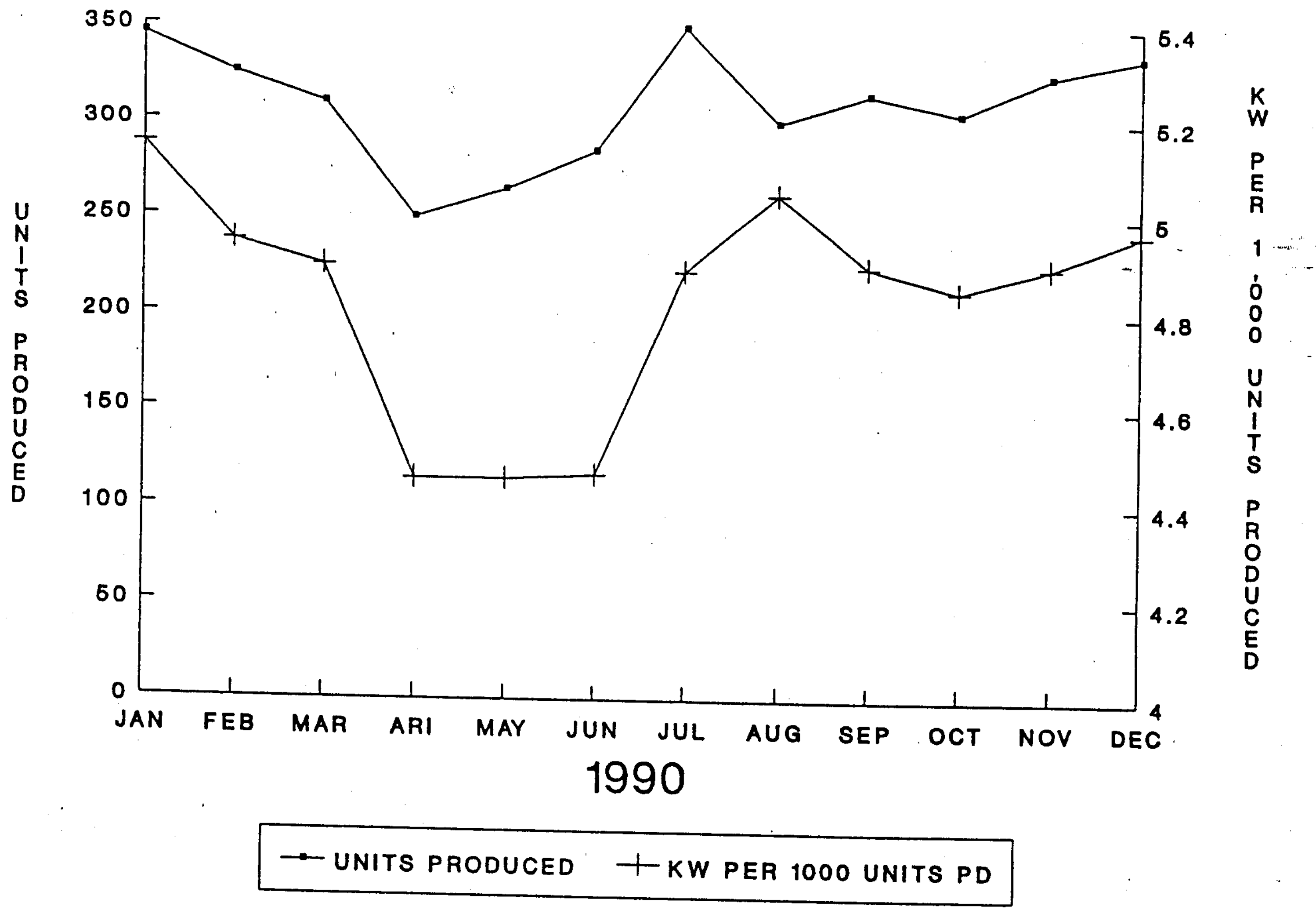
$$kWh_A = 1{,}716 \text{ kWh}$$

C. Compute savings

Savings for this one-hour period are:

$$\begin{aligned} \text{kWh savings} &= kWh_B - kWh_A \\ &= 1{,}927.2 - 1{,}716 \\ &= 211.2 \text{ kWh} \end{aligned}$$

FIGURE ONE


350
300
250
200
150
100
50
0
UNITS PRODUCED
5.4
5.2
5
4.8
4.6
4.4
4.2
4
KW PER 1,000 UNITS PRODUCED
JAN
FEB
MAR
ARI
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1990
UNITS PRODUCED
KW PER 1000 UNITS PD

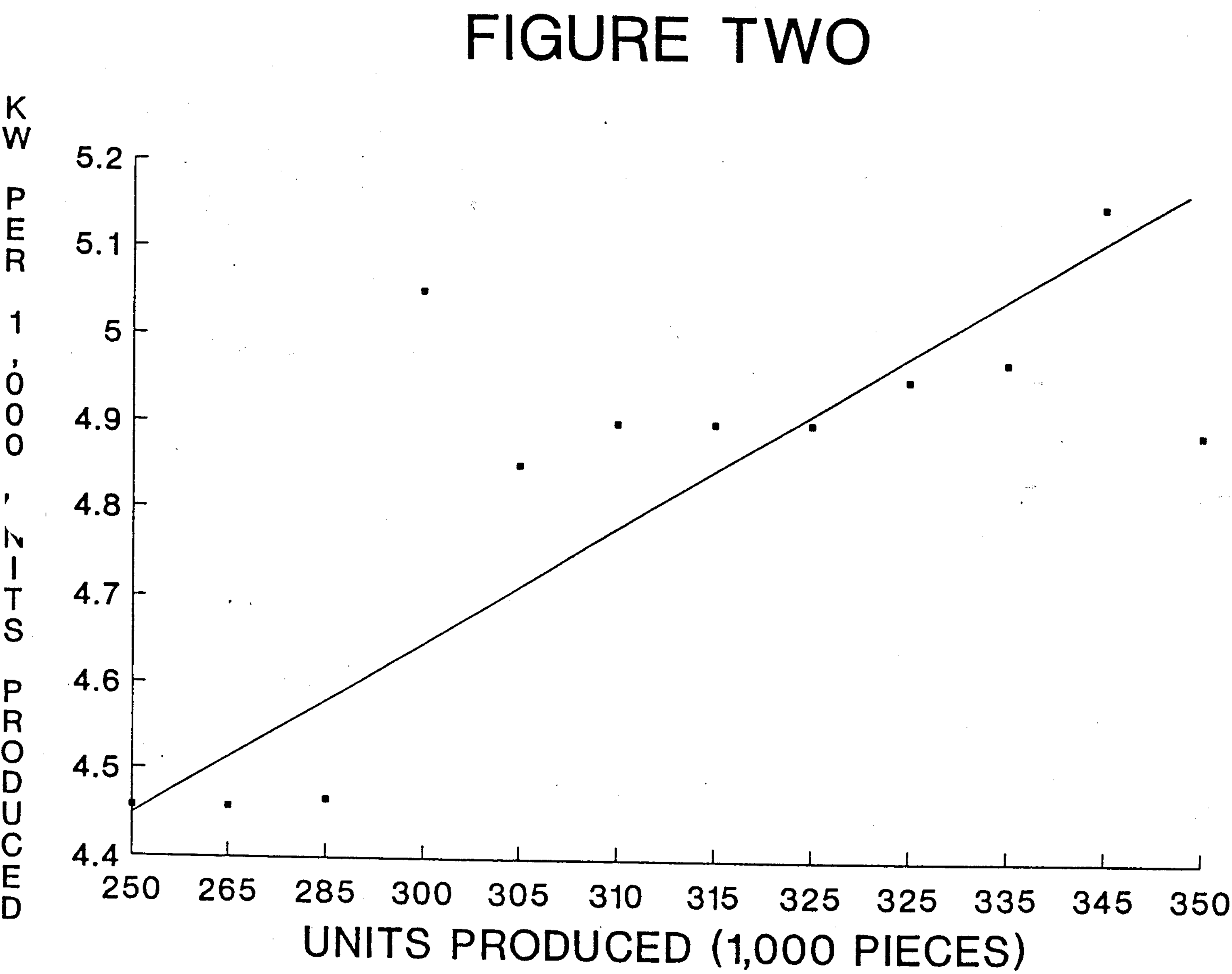


FIGURE TWO
KW PER 1,000 ,NITS PRODUCED
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
250 265 285 300 305 310 315 325 325 335 345 350
UNITS PRODUCED (1,000 PIECES)

APPENDIX E: MEASUREMENT EXAMPLES FOR METHOD 4A

EXAMPLE 1
TO
METHOD 4A

1. GENERAL DESCRIPTION OF OPPORTUNITY

An existing centrifugal chiller system delivers 47° F chilled water supply temperature. A eutectic thermal storage system is installed that shifts 800 tons of chiller operation from the Capacity Period to the off peak period.

2. FIELD SITUATION

The existing chiller system consists of: (i) two identical 700 ton McQuay centrifugal chillers; and (ii) 47° F chilled water supply temperature. Total (maximum annual) building cooling load is 1,400 tons.

The thermal storage system consists of: (i) 4,200 ton-hours; (ii) 42° F chilled water charging temperatures; and (iii) 47° F eutectic freeze/melt temperature.

3. METHOD

Install metering in conformance with the Protocol. Points installed include:

T1 - Chilled water return temperature before chiller
T2 - Water temperature from the building load
T3 - Chilled water supply temperature to building load
T4 - Chilled water supply temperature off chiller
T5 - Condenser water supply temperature
T6 - Water temperature out of storage
F1 - System flow rate (GPM)
F2 - Flow rate from storage (GPM)
E1 - Chiller 1 electric input (kW)
E2 - Chiller 2 electric input (kW)
E3 - Cooling tower fans electric input (kW)
E4 - Condenser water pump electric input (kW)
E5 - Storage booster pump electric input (kW)
E6 - Chilled water supply pump electric input (kW)

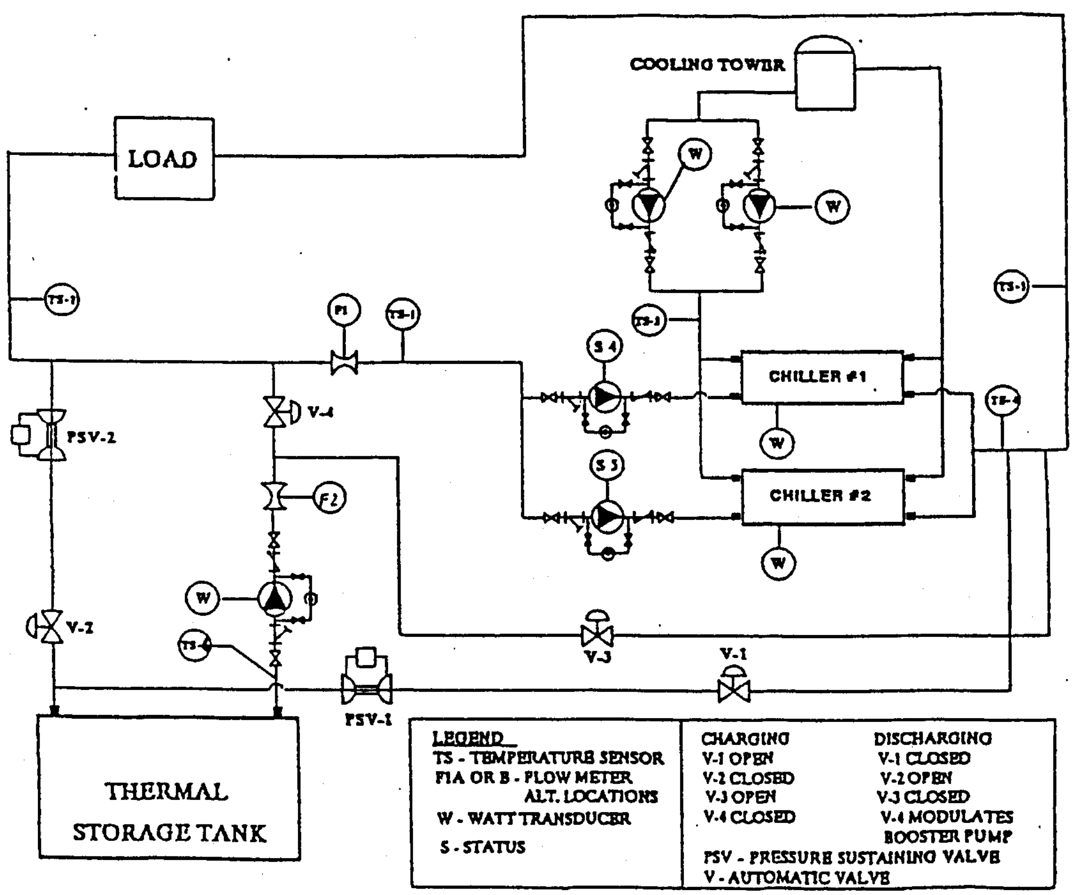
Compute hourly building load, TES tons (charging and discharging), kW per ton over range of operating conditions, Measured Cooling Demand and Simulated Cooling Demand in conformance with the methodology specified in the Protocol.

4. EXAMPLE CALCULATION

Tables 1 and 2 set forth sample calculations to illustrate the measurement methodology.

Based on the measurement points shown in Figure 1, Table 1 shows measurement data for the 1,400 ton peak system. This data is based upon a system with storage in operation.

Figure 1: Measurement Points for Cool Storage System



a. Table 1: Measurement Data with Storage Operation

Column 1:	TOD	Time of Day.
Column 2:	T1	Water Temperature into the chiller(s).
Column 3:	T4	Water temperature out of the chiller(s).
Column 4:	dt	Water temperature difference across the chillers (T4 - T1).
Column 5:	F1	System flow rate (GPM).
Column 6:	$Tons_{CH}$	Chiller tonnage: $\frac{(T4 - T1) * F1 * 500}{12,000}$
Column 7:	T5	Condenser water entering temperature.
Column 8:	E1 & E2	Chiller kW.
Column 9:	E3	kW of cooling tower fan(s) based on power transducer.
Column 10:	E4	kW of condenser water pump based on power transducer.
Column 11:	E4A	kW of second condenser water pump.
Column 12:	E6	kW of chilled water supply pump.
Column 13:	E6A	kW of second chilled water supply pump.
Column 14:	E5	kW of storage booster pump, based on kW transducer.
Column 15:	T3	Water temperature to the load.
Column 16:	T2	Water temperature from the load.
Column 17:	F1	System flow rate (GPM).

Column 18: Building cooling load (tons) = $\frac{(T3 - T2) * 500)}{12{,}000}$

Column 19: T4 Water temperature into storage during charging mode.

Column 20: T6 Water temperature out of storage.

Column 21: F2 Storage flow rate (GPM).

Column 22: Storage load = $\frac{(T4 - T6 * F2 * 500)}{12{,}000}$.

The total kWh usage on-peak and off-peak is tabulated at the bottom of Table 1.

Note that the data set forth in Table 1 are illustrative only, and do not accurately reflect the chiller performance curve (which would be programmed into the calculations), or the auxiliaries' cycling behavior.

Example 1 to Method 4A

Table 1
Actual Measurement With Storage Operation

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Chiller Load							Auxiliaries						Bldg. Load				Storage Load		
TOD	T1	T4	dt	F1	tons	T5	E1&E2	E3	E4	E4A	E6	E6A	E5	T2	T3	F1	tons	T6	T3	F2	tons
1	51.7	42	9.72	2500	1013	75	658	35	35	35	23	23	20	51.7	45.4	2500	713	45.3	42	2500	300
2	51.3	42	9.50	2500	990	75	644	35	35	35	23	23	20	51.5	45.4	2500	690	45.4	42	2500	300
3	51.1	42	9.19	2500	958	75	623	35	35	35	23	23	20	51.1	45.4	2500	658	45.4	42	2500	300
4	51.1	42	9.12	2500	950	75	618	35	35	35	23	23	20	51.1	45.4	2500	650	45.4	42	2500	300
5	50.9	42	8.97	2500	935	75	608	35	35	35	23	23	20	50.9	45.4	2500	635	45.4	42	2500	300
6	51.0	42	9.05	2500	943	80	660	35	35	35	23	23	20	51.0	45.4	2500	643	45.4	42	2500	300
7	51.4	42	9.42	2500	982	80	687	35	35	35	23	23	20	51.4	45.4	2500	682	45.4	42	2500	300
8	49.3	42	7.30	2500	761	80	533	35	35	35	23	23	0	52.8	45.4	2500	761	42	42	2500	0
9	50.5	42	8.53	2500	889	80	622	35	35	35	23	23	0	54	45.4	2500	889	42	42	2500	0
10	51.6	42	9.66	2500	1007	80	705	35	35	35	23	23	0	55.1	45.4	2500	1007	42	42	2500	0
11	52.5	42	10.3	2500	1103	80	772	35	35	35	23	23	0	56	45.4	2500	1103	42	42	2500	0
12	53.1	42	11.1	2500	1166	85	875	35	35	35	23	23	0	56.6	45.4	2500	1166	42	42	2500	0
13	48.4	45.4	3.08	2500	321	85	241	18	0	18	23	0	20	57.2	45.4	2500	1221	57.2	48.5	2500	-900
14	49.0	45.4	3.69	2500	385	85	289	18	0	18	23	0	20	57.8	45.4	2500	1285	57.2	49.1	2500	-900
15	50.0	45.4	4.60	2500	480	85	360	18	0	18	23	0	20	58.7	45.4	2500	1380	58.7	50.0	2500	-900
16	50.3	45.4	4.98	2500	519	85	389	18	0	18	23	0	20	59.1	45.4	2500	1419	59.1	50.4	2500	-900
17	55.7	42	13.7	2500	1432	85	1074	35	35	35	23	23	20	59.2	45.4	2500	1432			2500	0
18	55.5	42	13.5	2500	1412	80	988	35	35	35	23	23	20	59	45.4	2500	1412			2500	0
19	54.7	42	12.7	2500	1333	80	933	35	35	35	23	23	20	58.2	45.4	2500	1333			2500	0
20	56.6	42	14.6	2500	1521	80	1065	35	35	35	23	23	20	57.2	45.4	2500	1221	45.4	42	2500	300
21	55.3	42	13.3	2500	1387	80	971	35	35	35	23	23	20	55.9	45.4	2500	1087	45.4	42	2500	300
22	54.4	42	12.4	2500	1299	75	844	35	35	35	23	23	20	55	45.4	2500	999	45.4	42	2500	300
23	53.7	42	11.7	2500	1228	75	798	35	35	35	23	23	20	54.4	45.4	2500	928	45.4	42	2500	300
24	53.3	42	11.3	2500	1181	75	768	35	35	35	23	23	20	53.9	45.4	2500	881	45.4	42	2500	300
Totals					24195		16725	772	700	772	552	460	380				24195				
				kWh on-peak			7780	350	280	350	270	180	140								
				Total kWh on-peak			9350														
				kWh off-peak			8943	420	420	420	270	270	240								
				Total kWh off-peak			10983														

b. Table 2: Simulated Energy Usage for Same Day Without Storage

Table 2 involves taking data from the actual system operation with storage and using it to simulate the operation and energy usage of a conventional system without storage the same day.

Column 1:	TOD	Time of Day.
Column 2 :	T2	Temperature into the chiller(s), assumed to be the same as the return building temperatures (T3) in the storage operation.
Column 3:	T3	Temperature out of the chiller, assumed to be the same as the building supply temperature (T2) in the storage operation.
Column 4:	dt	Temperature differential across the chiller (calculated) (T2 - T3).
Column 5:	F1	Flow rate (GPM), same as in storage operation.
Column 6:	Tons	Calculated building cooling load (tons), where tons = $\frac{(T2 - T3) * F1 * 500}{12{,}000}$.
Column 7:	T5	Condenser water temperature.
Column 8:	CH-kW	Chiller kW calculated from chiller tonnage and performance curve as developed pursuant to Paragraph 2.c. in Method 4 of the Protocol.
Column 9: Through Column 13:	E1-E4, E6	Calculated auxiliary loads based on calculated chiller load, operating conditions, and assumed cycling pattern.
Column 14:	E5	Storage circulation pump electric input. No storage pump is included in the conventional case.

Total on-peak and off-peak kWh is calculated and shown at the bottom of Table 2 for the conventional case. A comparison is made with the storage case to determine the electric power savings.

Note that this example is illustrative only and does not necessarily include accurate chiller part-load performance or auxiliaries cycling behavior.

Table 2
Simulated Measurement Data Without Storage

	Bldg. Lodge Chiller Load							Auxiliaries					
1	2	3	4	5	6	7	8	9	10	11	12	13	14
TOD	T2	T3	F1	dt	tons	T5	ch kw	E1	E2	E3	E4	E6	E5
1	52.2	45.5	2500	6.8	713	75	463.4	35	35	35	23	23	0
2	52.0	45.5	2500	6.6	690	75	448.5	35	35	35	23	23	0
3	51.7	45.5	2500	6.3	658	75	427.7	35	35	35	23	23	0
4	51.4	45.5	2500	6.2	650	75	422.5	35	35	35	23	23	0
5	51.4	45.5	2500	6.1	635	75	412.7	35	35	35	23	23	0
6	51.5	45.5	2500	6.2	643	80	450.1	35	35	35	23	23	0
7	51.9	45.5	2500	6.5	682	80	477.4	35	35	35	23	23	0
8	52.7	45.5	2500	7.3	761	80	532.7	35	35	35	23	23	0
9	53.9	45.5	2500	8.5	889	80	622.3	35	35	35	23	23	0
10	55.0	45.5	2500	9.7	1007	80	704.9	35	35	35	23	23	0
11	55.9	45.5	2500	10.6	1103	80	772.1	35	35	35	23	23	0
12	56.5	45.5	2500	11.2	1166	85	874.5	35	35	35	23	23	0
13	57.1	45.5	2500	11.7	1221	85	915.7	35	35	35	23	23	0
14	57.7	45.5	2500	12.3	1285	85	963.7	35	35	35	23	23	0
15	58.6	45.5	2500	13.2	1380	85	1035	35	35	35	23	23	0
16	59.0	45.5	2500	13.6	1419	85	1064	35	35	35	23	23	0
17	59.1	45.5	2500	13.7	1432	85	1074	35	35	35	23	23	0
18	58.9	45.5	2500	13.6	1412	80	988.4	35	35	35	23	23	0
19	58.1	45.5	2500	12.8	1333	80	933.1	35	35	35	23	23	0
20	57.1	45.5	2500	11.7	1221	80	854.7	35	35	35	23	23	0
21	55.8	45.5	2500	10.4	1087	80	760.9	35	35	35	23	23	0
22	54.9	45.5	2500	9.6	999	75	699.3	35	35	35	23	23	0
23	54.3	45.5	2500	8.9	928	75	649.6	35	35	35	23	23	0
24	53.6	45.5	2500	8.5	881	75	616.7	35	35	35	23	23	0
Totals					24195		17163.9	840	840	840	552	552	0
kWh on-peak							10480	420	420	420	270	270	
Total kWh on-peak							12280						
kWh off-peak							6683	420	420	420	270	270	
Total kWh off-peak							8483						

c. To calculate demand reduction during applicable Utility Time Periods, use the following equation:

Demand reduction during Utility Time Period =

$$\frac{\text{(Simulated kWh consumption from Table 2) - (Actual kWh consumption from Table 1)}}{\text{Capacity period hours}}$$

$$\text{Demand reduction} = \frac{(12{,}280\text{ kWh} - 9{,}350\text{ kWh})}{6\text{ hrs}}$$

$$= \frac{2{,}930\text{ kWh}}{6\text{ hrs}}$$

$$= 488.3\text{ kW}$$

d. To calculate the total net energy consumption over the course of a day with storage, use the following equation:

Total net energy consumption =

(Total energy consumption of chillers and auxiliaries with storage from Table 1) - (Total simulated consumption of chillers and auxiliaries without storage from Table 2)

Total net energy consumption = (20,333 kWh - 20,763 kWh)

= - 430 kWh

or a net total energy reduction of 430 kWh calculated for this day's operation.